BRINGING DISCOVERY TO LIGHT

2023

asia RESEARCH NEWS

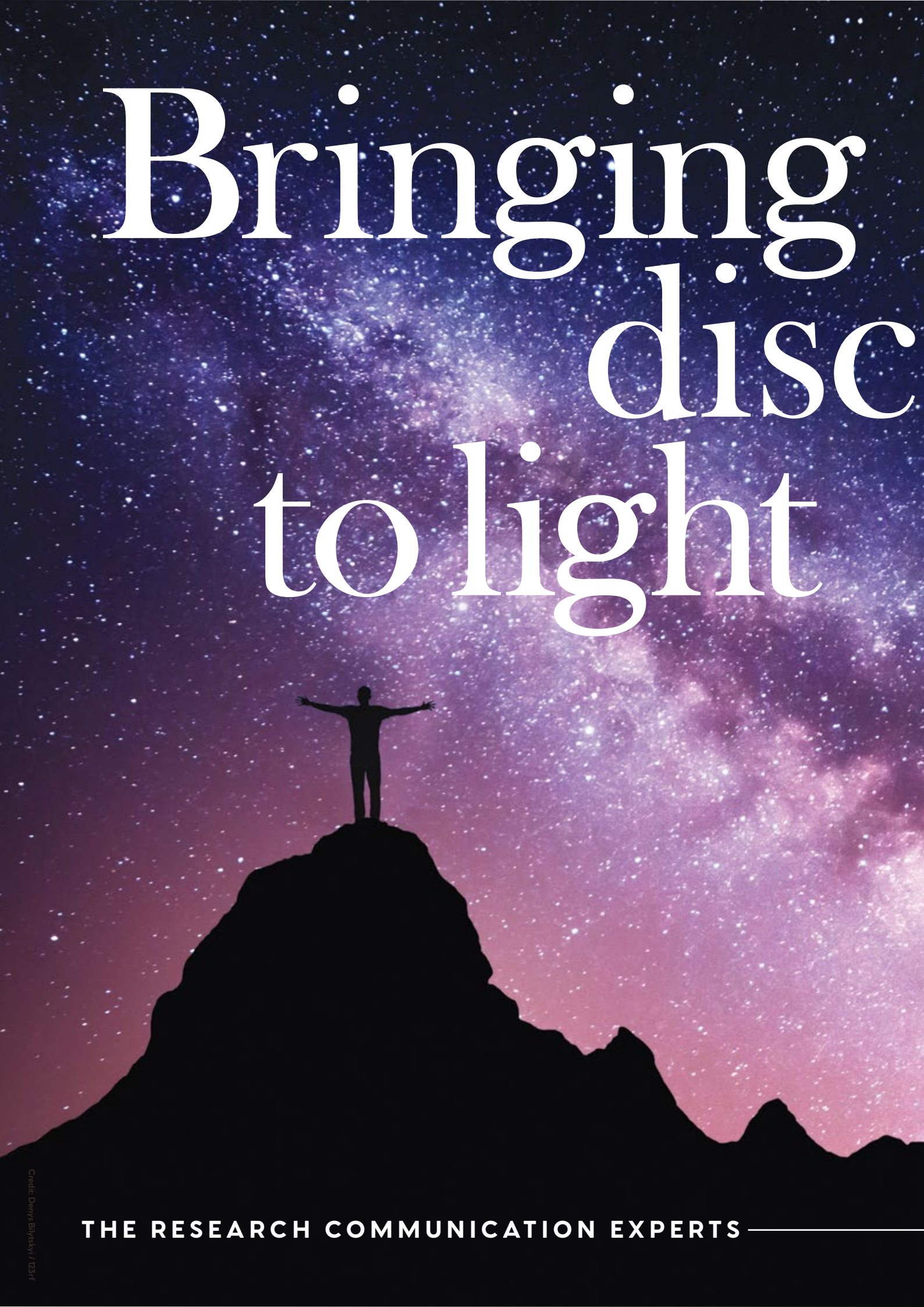
new age for materials

Innovative advances changing lives

also inside

- Bacteria power
- Robots and hearts
- Rice paddy arsenic traps
- Bridging diversity divides

Bringing disc to light

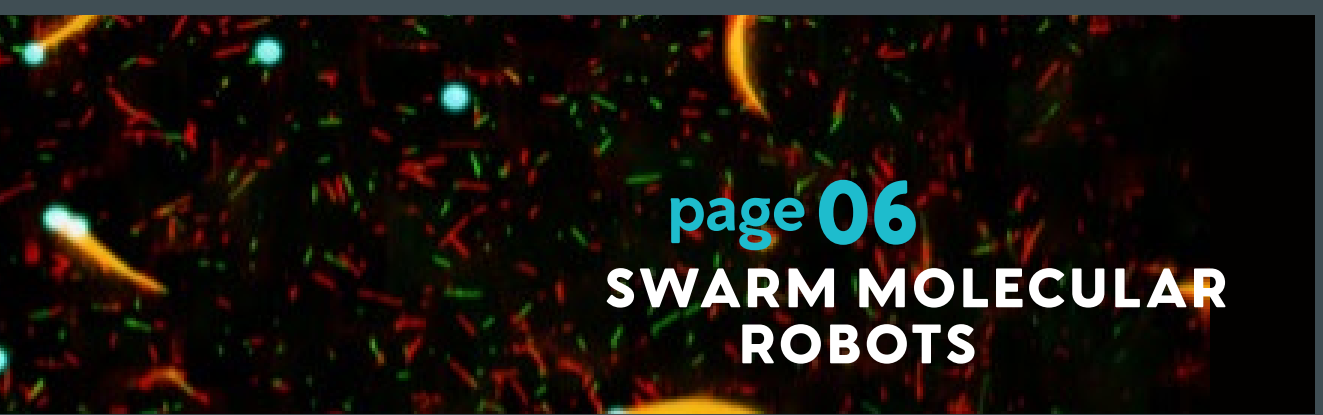


Credit: Denys Bilytsky / 123rf

THE RESEARCH COMMUNICATION EXPERTS


overy
Share your research
Spread the knowledge
asia
RESEARCH NEWS

contents



Our cover image is an artistic representation of advanced technologies helping us live sustainably.

Stay up-to-date with Asia go to
asiaresearchnews.com

Join our growing community

Reach the next level with Asia's premier communication experts
Explore our services

Contact us
info@asiaresearchnews.com

ISSN 2042-0536

editor's desk

Credit: Patrice Cipriani Ko | 123rf

I love my job. Each day, I learn about how scientists are striving to improve the world we live in and at Asia Research News, we get to share the research and spread the knowledge.

In this issue, we bring you innovations changing lives, from low cost creativity to high tech solutions; the personal journey of scientists and initiatives supporting research and communications.

Read about ingenious ways to generate electricity with just water and a shake or harnessing bacteria, seashells and blood for green power, utilizing machine learning for sustainable materials and how virtual reality just got more real.

We feature stories on molecular robots teaming up to deliver cargo, scientists keeping arsenic away from our food, the cost of reproduction, micro-robots and magnets guiding heart surgeries, better ways to heal wounds and broken bones, immune responses to vaccines, plant evolution and how rearranging solar cells and 2-D materials brings vast changes.

Research doesn't stop even in conflict. Find out more about an initiative continuing to support Myanmar research and higher education. Learn about why public outreach is a way to return taxpayer's investment in science and how to communicate about life beyond earth and other big news.

Get to know five scientists delving into the big questions about the universe, from how it began to dark energy and quantum ripples, using astrophysical skills for medical advances and the interplay of maths and geometry plus an astronomer's unexpected journey.

Magdaline Isbar
Founder and CEO

Get to know
Scientists from past and present inspiring our future

Giants in History | **Researchers** | **Experts for media**

SWARM MOLECULAR ROBOTICS DELIVERS CARGO

Scientists have shown that swarming molecular robots can deliver cargo five times more efficiently than a robot working on its own.

Some birds evolved to travel in swarms for more efficient movement. The swarming molecular machines can transport cargo 10 times larger and 5 times more efficiently than a single machine.

Credit: 123rf | udol72

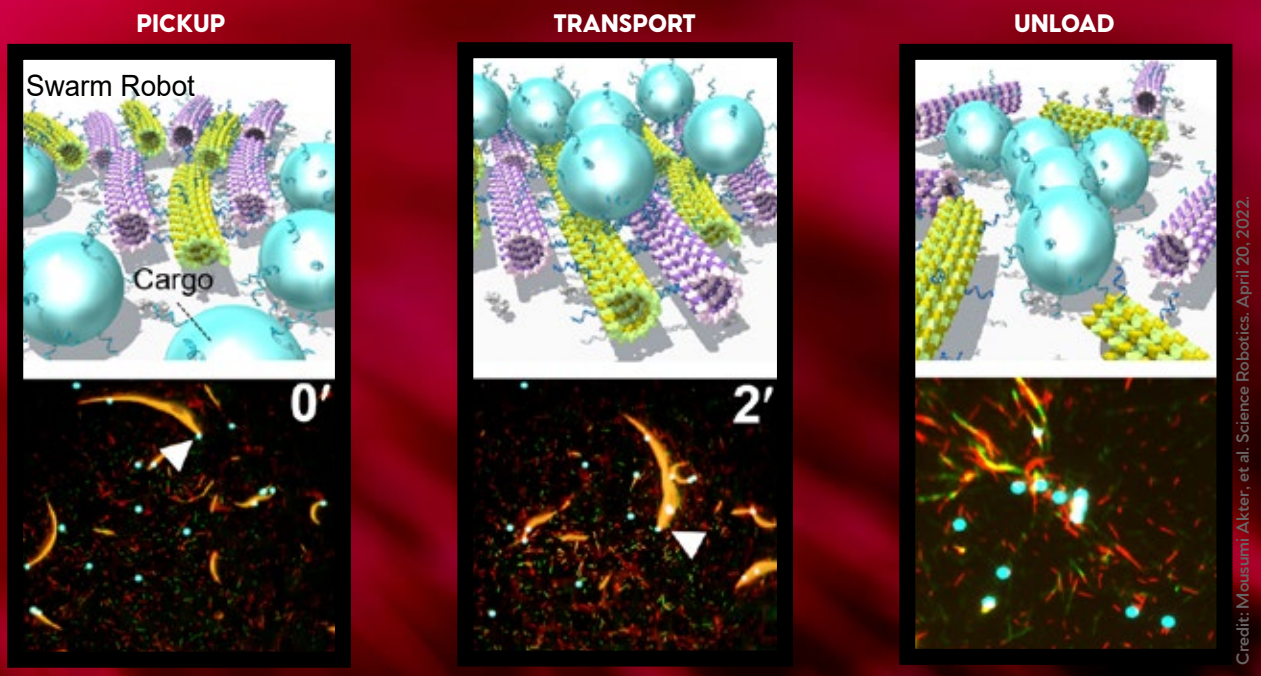
Swarm robotics is a new discipline, inspired by the cooperative behaviour of living organisms. It involves fabricating robots and getting them to swarm together to accomplish complex tasks. Macro-scale swarm robots have been developed and employed for a variety of applications, such as transporting and accumulating cargo, forming shapes, and building complex structures.

Now, researchers led by Hokkaido University physical chemist Akira Kakugo have developed tiny micro-sized machines that take advantage of swarming behaviour. Their findings were published in the journal *Science Robotics*.

A swarm of cooperating robots gains characteristics not possible for individual

Watch "Molecular deliveries: Coming soon."

Further information
Assoc Prof Akira Kakugo | kakugo@sci.hokudai.ac.jp
Department of Mechanical Engineering
Hokkaido University



Credit: Mousumi Akter, et al. Science Robotics, April 20, 2022.

A swarm of molecular robots (yellow and purple cylinders) collect, transport and unload cargo (blue spheres) in the top images. In the fluorescent images (bottom), the molecular robots appear as orange tails and cargo as blue dots.

robots. They can divide a workload, respond to risks, and even create complex structures in response to changes in the environment. Single robots and machines at the micro- and nano-scale have very few practical applications due to their incredibly small size. If they could cooperate in swarms, however, their potential uses would massively increase.

The team constructed about five million single molecular machines composed of two biological components: microtubules linked to DNA, which allowed them to swarm; and kinesin, a motor protein capable of transporting the microtubules. The DNA was combined with a light-sensitive compound called azobenzene. Changes in azobenzene's structure upon exposure to light triggered the DNA to form double strands, connecting the microtubules in a swarm. Exposure to UV light reversed this process.

The scientists tested the transportation of tiny polystyrene beads treated with azobenzene-linked DNA. They loaded onto the microtubules when exposed to visible light and were unloaded when exposed to UV light. The DNA and azobenzene used on the cargo were different from those used for the robots so that swarming could be controlled independently of cargo-loading.

Whereas a single machine can load and transport polystyrene beads up to three micrometres in diameter, swarms of machines were able to transport cargo as large as 30 micrometres in diameter. The swarms were also up to five times more efficient with regards to transportation distance and volume.

By demonstrating that molecular machines can be designed to swarm and cooperate to transport cargo with high efficiency, the study lays the groundwork for the application of microrobots to various fields.

"In the near future, we expect to see microrobot swarms used in drug delivery, contaminant collection, molecular power generation devices, and micro-detection devices," says Kakugo.

"In the near future, we expect to see microrobot swarms used in drug delivery, contaminant collection, molecular power generation devices, and micro-detection devices.

Credit: 123rf | kasezo

THE *AMORPHOPHALLUS* PLANTS OF BORNEO

Insights into their diversity will help to understand and protect them and their natural environment.

Credit: 123rf | aksenovko

A study of the *Amorphophallus* plants on Borneo shines new light on the evolutionary relationships among different members of this plant group. Wong Sin Yeng and colleagues at the Institute of Biodiversity and Environmental Conservation at Universiti Malaysia Sarawak report their findings in the journal *Taiwania*.

"This work and our wider research on the complex mutualistic relationships between plants and their environment helps guide sound decisions on conservation policies to secure the long-term future of diverse native plant species and their natural habitats," says Wong.

Wong Sin Yeng is en-route to fieldwork on the Serenau River in Kapit, Sarawak.

Amorphophallus is a plant genus comprising approximately 220 species of mainly lowland plants. They grow in tropical and subtropical zones from West Africa to the Pacific Islands and Japan. The centre of greatest diversity is focused on Indomalaya. 19 indigenous species are found on the large island of Borneo in the South China Sea.

The name *Amorphophallus* derives from the plants' prominent central flowering structure, called a spadix. The most famous species, although not found on Borneo, is the huge titan arum, which produces the world's largest unbranched flower structure.

Wong and her colleagues conducted genetic analyses to better understand the evolutionary relationships among the various *Amorphophallus* species of Borneo. This involved extracting and sequencing DNA from two regions of the plants' chromosomes, and one region of the DNA in sub-cellular organelles called plastids. The team performed 123 sequence analyses, representing 46 plant individuals.

The results allowed the researchers to construct a phylogenetic tree of the *Amorphophallus* plants they had studied. Visually, this is a branching diagram depicting the evolutionary relationships among the sampled species, but the genetic details used to construct the tree contain deeper information.

The work also explored the varying structure and biology of three species of *Amorphophallus* flowers, and the diversity of creatures interacting with them. This adds insights about the interrelationships between the flowers and their local habitat.

Over the next few years, Wong aims to investigate more of the Bornean species. She expects this may reveal that currently defined single species may actually be several different species despite their outwardly similar appearances. Detailed genetic analysis is the only reliable way to probe such hidden complexities.

While the molecular genetics reveal the evolutionary secrets, the field trips into the world of the plants are equally inspiring for Wong. "Every visit to the forest, every hour spent observing plants and their insect visitors, every time the results of a lab analysis are revealed, is a moment of discovery bringing new understanding and insight into a process that has been millions of years evolving," she says.

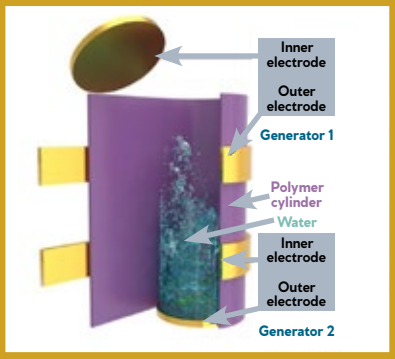
The beetles use the bloom of *Amorphophallus* plants as mating chamber while acting as pollinators for the species.

***Amorphophallus eburneus* is a species found in a very limited area of the karst limestone forest in the southwest of Sarawak.**

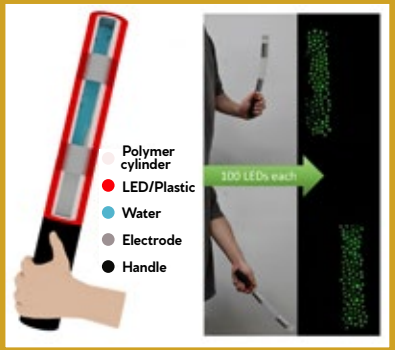
Further information
Assoc. Prof Wong Sin Yeng | sywong@unimas.my
Institute of Biodiversity and Environmental Conservation
Universiti Malaysia Sarawak

POUR WATER AND SHAKE FOR ELECTRICITY

Shaking the compact, lightweight device generates enough electricity to power 100 LEDs.



The device's simple design consists of 10ml of water, a polymer cylinder and electrodes.



The nanogenerators can have a wide range of everyday applications. Here is an example of its use as a safety light baton.

A new stick-like, water-based device can convert energy from movement into electricity. The technology, which was reported in the journal *Science and Technology of Advanced Materials*, could be used to power portable devices, such as safety lights.

Growing interest in the Internet-of-things and small electronics has created high demand for portable energy sources. One way to produce power is to harvest energy from the environment, such as thermal, solar or mechanical energy. To capture mechanical energy – the power an object gets from its position and motion – scientists have developed triboelectric nanogenerators, which can produce electricity through friction.

"Triboelectric nanogenerators are one of the most effective tools for harvesting mechanical energy because of their high electrical output, low cost and easy accessibility," explains mechanical engineer Sangmin Lee of Chung-ang University in the Republic of Korea.

Triboelectric generators become electrically charged when two dissimilar materials touch and then separate. For example, when a balloon is rubbed on clothing, it becomes charged and can stick to things. However, friction between two materials inevitably causes damage, reducing device lifespan.

Using liquids can reduce friction, but liquid-based generators have considerably lower electrical output compared to solid ones. There is also a trade-off between making the device large enough for the liquid to move and generate electricity, while also ensuring it is compact enough to be portable.

To overcome these problems, Lee and colleagues in South Korea and the US developed a lightweight, compact, water-based generator that can produce electrical power when shaken.

The device has a simple stick-like design and consists of 10ml of water, a polymer cylinder and electrodes. The container's polymer material is negatively charged. The water moves up and down when the device is shaken, acquiring a positive charge that is transferred to the electrodes to generate a high electrical output.

"Because of its simple mechanism and design, this small, lightweight device could be used in everyday life. Electrical power can be produced simply by pouring water into the generator then giving it a shake," explains Lee.

The researchers tested different designs, changing the size of the electrodes, the physical space between them and the amount of water to determine the optimal combination. They found that the portable stick could generate a high electrical output, reaching 710 volts, when it had adequate space for water movement and a high electrode area.

The researchers showed that the generator can power 100 LED lights, meaning it could be used as a traffic safety light baton that illuminates when shaken. This study demonstrates the potential for triboelectric nanogenerators to be used for a wide range of everyday applications.

Prof Sangmin Lee | sleeg8@cau.ac.kr
School of Mechanical Engineering
Chung-ang University, Republic of Korea

Dr Yasufumi Nakamichi | nakamichi.yasufumi@nims.go.jp
Science and Technology of Advanced Materials
National Institute for Materials Science

Further information

MACHINE LEARNING SEARCHES FOR SUSTAINABLE MATERIALS

A model that rapidly searches through large amounts of materials could find sustainable alternatives to existing composites.

Researchers from Konica Minolta and the Nara Institute of Science and Technology in Japan have developed a machine learning method to identify sustainable alternatives for composite materials. Their findings were published in the journal *Science and Technology of Advanced Materials: Methods*.

Composite materials are compounds made of two or more constituents. Due to the complex nature of the interactions between the different components, their performance can greatly exceed that of single materials. Composite materials, such as fibre-reinforced plastics, are very important for a wide range of industries and applications, including electrical and information technologies.

In recent years, there has been increasing demand for more environmentally sustainable materials that help reduce industrial waste and plastic use. One way to achieve this is to substitute the constituent materials in composites with recyclable materials or biomass. However, this can reduce performance compared to the original material.

"Finding a new composite material that achieves the same performance as the original using human experience and intuition alone takes a very long time because you have to evaluate countless materials while also taking into account the interactions between them," explains Michihiro Okuyama, assistant manager at Konica Minolta, Inc.

Machine learning offers a potential solution to this problem. Scientists have proposed several machine learning methods to conduct rapid searches among a large number of materials, based on the relationship between the materials' features and performance. However, in many cases the properties of the constituent materials are unknown, making these types of predictive searches difficult.

To overcome this limitation, the researchers developed a machine learning method that can quantitatively evaluate the interactions between component materials to reveal how much they contribute to the overall performance of the composite. The method then searches for replacement constituents with similar performance to the original material.

The researchers tested their method by searching for alternative constituents for a composite consisting of resin, a filler and an additive. They experimentally evaluated the performance of the substitute materials identified by machine learning and found they were similar to the original material, demonstrating that the model works.

"Our new machine learning method removes the need to test large numbers of candidates by trial and error, saving time and money," says Okuyama.

Credit: 123rf | amenic181 with Pixbay composite

Further information
Michihiro Okuyama | michihiro.okuyama@konicaminolta.com
Assistant Manager, Principal Data Scientist
Konica Minolta, Inc.

Dr Yasufumi Nakamichi | nakamichi.yasufumi@nims.go.jp
Science and Technology of Advanced Materials
National Institute for Materials Science

Better. Faster.

Always accelerating
materials science development.

STAM Methods

Science and Technology of Advanced Materials: Methods

Leading the way exploring

· Methodology · Apparatus · Modeling · Instrumentation
· Data mining and analysis · AI · High throughput screening
and other emergent methods and tools

tandfonline.com/stam-m

STAM Science and Technology of Advanced Materials

NIMS National Institute for Materials Science

Empa Materials Science and Technology

Taylor & Francis Group
an **informa** business

stam-methods@ml.nims.go.jp

NOVEL PATCHING MATERIAL FOR BONE DEFECTS

Scientists at Tokyo Medical and Dental University have discovered a new type of bone-repairing material that could be used to more precisely fix bone defects.

Ceramics and metals have been used for a while as structural materials to repair bones and joints. In the past, scientists engineered bioinert materials, which do not bond to bones directly; bioactive materials that can bond to bones; and bioabsorbable materials that are categorized as bioactive materials but are absorbed by the body over time and replaced by advancing bone tissue.

Now, a fourth type of bone-repairing materials has been found: a bioresponsive ceramic that interacts with an enzyme found in blood to be absorbed into the body at a precise and predictable rate.

The research was done by Taishi Yokoi, of the Institute of Biomaterials and Bioengineering at Tokyo Medical and Dental University, and his colleagues. The study was published in *Science and Technology of Advanced Materials*.

At the heart of their discovery is a biological reaction: an enzyme called alkaline phosphatase (ALP), which is present in human serum and reacts with various phosphate esters to generate a bone mineral known as hydroxyapatite.

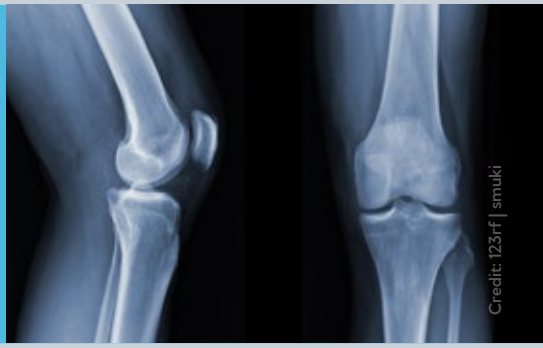
The scientists placed four different salts in simulated body fluid containing or lacking the enzyme ALP. The salts were calcium salts of methyl phosphate (CaMeP), ethyl phosphate (CaEtP), butyl phosphate (CaBuP) and dodecyl phosphate (CaDoP). The phosphate component of each salt has an alkyl group at its end – a chain composed of hydrogen and carbon atoms – of differing lengths.

The scientists found that the first three salts were converted to hydroxyapatite, but only in the presence of ALP. Interestingly, the length of the alkyl group on the phosphate ester determined the rate at which this reaction happens. With more research, the scientists think this could allow greater control of the bone healing process in the body.

"We expect the findings of this study will be applied for designing and developing novel bone-repairing materials with precisely controlled degradation and resorption rates inside the body," says Yokoi.

Did you know?

Bone fractures impact wellness and pose a serious economic burden worldwide, keeping people from work and causing disability, impaired quality of life, and high medical costs. In 2019 alone, there were 178 million new fractures globally, with incidences highest in the oldest age groups.



Credit: 123rf | smuki

Source: GBD 2019 Fracture Collaborators. The Lancet 2.9 E580-592 (2021).

Credit: 123rf | toeytoey

Further information

Assoc Prof Taishi Yokoi | yokoi.taishi.bcr@tmd.ac.jp
Institute of Biomaterials and Bioengineering
Tokyo Medical and Dental University

Dr Yasufumi Nakamichi | nakamichi.yasufumi@nims.go.jp
Science and Technology of Advanced Materials
National Institute for Materials Science

TINY ELECTRIC GENERATORS AID WOUND HEALING

Researchers are working to overcome challenges in order to bring wearable, electric, wound-healing devices to clinical practice.

Credit: 123rf | mingirov

Tiny dressings that generate electricity in response to movement could accelerate wound healing and tissue regeneration. Scientists in Taiwan reviewed the latest advances and potential applications of wound healing technology in the journal *Science and Technology of Advanced Materials*.

The natural wound healing process involves complex interactions between ions, cells, blood vessels, genes and the immune system; with every player triggered by a sequence of molecular events. An integral part of this process involves the generation of a weak electric field by the damaged epithelium – the layer of cells covering tissue. The electric field forms as a result of an ion gradient in the wound bed, which plays an important role in directing cell migration and promoting blood vessel formation in the area.

Scientists discovered in the mid- to late-1900s that stimulating tissue with an electric field could improve wound healing. Current research in this field is now focused on developing small, wearable and inexpensive patches that aren't encumbered by external electrical equipment.

This has led to research on piezoelectric materials, including natural materials like crystals, silk, wood, bone, hair and rubber, and synthetic materials such as quartz, ceramics and polymers. These materials generate an electric current when exposed to mechanical stress. Nanogenerators made with synthetic materials are especially promising.

For example, some research teams are exploring the use of self-powered piezoelectric nanogenerators made with zinc oxide nanorods on a polydimethylsiloxane matrix for accelerating wound healing. Zinc oxide has the advantage of being piezoelectric and biocompatible. Other scientists are using scaffolds made from polyurethane and polyvinylidene fluoride (PVDF) due to their high piezoelectricity, chemical stability, ease of manufacturing and biocompatibility. These and other piezoelectric nanogenerators have shown promising results in laboratory and animal studies.

Another type of device, called a triboelectric nanogenerator (TENG), produces an electric current when two interfacing materials come into and out of contact with each other. Scientists have experimented with TENGs that generate electricity from breathing movements, for example, to accelerate wound healing in rats. They have also loaded TENG patches with antibiotics to facilitate wound healing by also treating localized infection.

"Piezoelectric and triboelectric nanogenerators are excellent candidates for self-assisted wound healing due to their light weight, flexibility, elasticity and biocompatibility," says bioengineer Zong-Hong Lin of the National Tsing Hua University in Taiwan. "But there are still several bottlenecks to their clinical application."

For example, they still need to be customized so they are fit-for-size, as wound dimensions vary widely. They also need to be firmly attached without being negatively affected or corroded by the fluids that naturally exude from wounds.

"Our future aim is to develop cost-effective and highly efficient wound dressing systems for practical clinical applications," says Lin.

Prof Zong-Hong Lin | linzh@mx.nthu.edu.tw
Institute of Biomedical Engineering
National Tsing Hua University

Dr Yasufumi Nakamichi | nakamichi.yasufumi@nims.go.jp
Science and Technology of Advanced Materials
National Institute for Materia ls Science

Further information

JOIN

THE ASIA RESEARCH NEWS *Community*

RESEARCHERS

INSTITUTIONS

JOURNALISTS

PUBLIC

AsiaResearchNews.com

BAITING ARSENIC IN RICE PADDY FIELDS

Naturally formed iron oxides on the surface of plastic tubes offer an inexpensive and sustainable method to reduce arsenic contamination in crops.

Arsenic contamination in flooded paddy fields threatens the health of more than half of the world's population who rely on rice as their main staple food. Existing methods to remove the arsenic are expensive, require added chemicals and can degrade the quality of the soil. Researchers, led by Zheng Chen at Xi'an Jiaotong-Liverpool University in China, have pioneered a simple, inexpensive and sustainable alternative using plastic tubes coated with naturally forming iron oxides, which are inserted into the soil. They describe their method in the *Journal of Hazardous Materials*.

"Iron oxides can absorb large amounts of arsenic, so we wondered if it would be possible to use them as a trap for this poisonous element. In our first attempt, we found the arsenic naturally took the bait," says Chen.

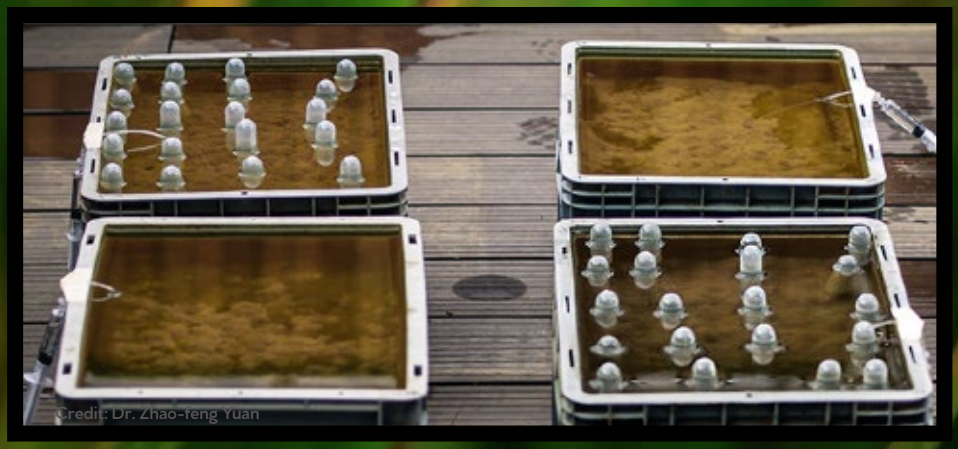
Iron oxides occur naturally at high levels in localized regions of soil, for example at the soil-water interface and on the root surfaces of wetland plants. These small regions are dispersed throughout the soil, however, making it difficult to separate the complexes of iron oxides and arsenic for removal. The team knew, from other workers' research findings dating from the 1980s, that plastics in flooded soil can naturally induce iron oxides to form on their surface.

This existing knowledge led them to investigate the factors influencing the formation of plastic-induced iron oxides, including differences in the types of plastic, their structures, the properties of soils, and the soil's exposure to light, nitrate, and oxygen. Experiments revealed that low-density porous polyethylene tubes that allow oxygen to pass through the tube walls can induce the formation of large amounts of iron oxides. They also established a direct correlation between the amount of iron oxides formed and the capture of arsenic by what Chen calls the iron oxide "hooks".

The system of tubes inserted at regular intervals reduced the arsenic content of rice grown in trial plots by more than 10%. This improvement will hopefully be increased further as the procedure is developed.

Another refinement to be explored is the option of replacing the polyethylene with biodegradable plastics such as polylactic acid, to avoid the risk of long-lasting polluting microplastics particles contaminating the soil.

"The tubes are inexpensive, they can be re-used after the small amount of arsenic-containing solid waste is removed, and automating the process of tube insertion and removal could further reduce the costs and increase the effectiveness of this novel soil remediation technology," Chen concludes.



Credit: Dr. Zhao-feng Yuan

The containers storing arsenic-tainted soils from rice fields. Some containers (top-left and bottom-right) have plastic tubes with iron oxides, or "hooks", that trap arsenic.

Credit: HD Wallpaper

Senior Assoc Prof Zheng Chen | Zheng.Chen@xjtlu.edu.cn
Department of Health and Environmental Sciences
Xi'an Jiaotong-Liverpool University

Further information

ULTRATHIN, WIRELESS PALM PATCH BRINGS TOUCH TO VIRTUAL REALITY

Tactile sensations could soon be coming to virtual reality, surgical robotics and prosthetic sensing.

Credit: Dr Yu Xinge's research group | City University of Hong Kong

With the 'WeTac' system, the user can feel an augmented-reality mouse running on the palm as tactile sensation is stimulated with electronic current through the hand patch.

The sense of touch may soon be added to the virtual gaming experience, thanks to an ultrathin wireless patch that sticks to the palm of the hand. The patch simulates tactile sensations by delivering electronic stimuli to different parts of the hand in a way that is individualized to each person's skin. Developed by researchers at City University of Hong Kong (CityU) with collaborators and described in the journal *Nature Machine Intelligence*, the patch has implications beyond virtual gaming, as it could also be used for robotics surgery and in prosthetic sensing and control.

'Haptic' gloves, that simulate the sense of touch, already exist but are bulky and wired, hindering the immersive experience in virtual and augmented reality settings. To improve the experience, researchers led by CityU biomedical engineer Yu Xinge

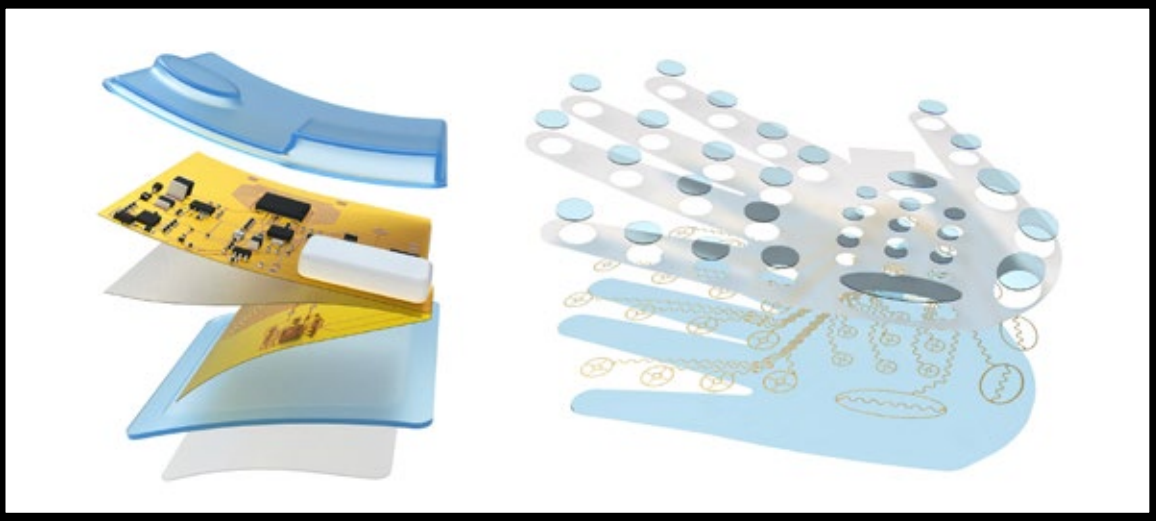
Did you know?

The human hand has approximately 100,000 nerves and fingertips are one of the most touch-sensitive parts of the human body, followed by the lip and tongue respectively. Touch sensation from a fingertip to the brain travels at up to 200 feet (approx. 70 metres) per second.

Source: The Handy Guide to Touch, By Elise Hancock, Johns Hopkins Magazine

Credit: 123rf | neoleo3d

Further information
Assoc Prof Yu Xinge | xingeyu@cityu.edu.hk
Department of Biomedical Engineering
City University of Hong Kong



Credit: Dr Yu Xinge's research group | City University of Hong Kong

The new tactile system consists of a driver unit (left) and a hydrogel-based electrodes hand patch (right). The driver unit is controlled by a mobile device and outputs electric current to the user's hand through 32 sites on the hand patch.

developed an advanced, wireless, haptic interface system called 'WeTac'.

It works by initially decoding the user's specific sensitivity map from the palm of their hand. "The sensitivity of tactile sensation varies widely on different parts of the hand and from one person to another," explains Xinge. As part of their research, the scientists measured the tactile sensation thresholds of 14 healthy volunteers of different genders and ages. They found that the palms of women and young people were relatively more sensitive to touch compared to men and the elderly, respectively. Also, people involved in manual jobs, like cleaning, who had thicker skin and/or calluses on their hands, required stronger electrical current pulses to elicit a sensation compared to those who didn't.

WeTac works by sending electronic impulses from a small device placed on the forearm to an ultrathin palm patch containing hydrogel-based electrodes. The strength of the impulses is individualised according to each person's sensitivity map so that they aren't too weak as not to be felt or so strong that they are painful. The impulses can be sent to 32 different sites on the palm to simulate tactile sensations, including pressure and movement.

The palm patch is very flexible, thin (220 μm to 1 mm), and porous to prevent sweat accumulation. The forearm device is also flexible, light (19.2 g), and small (5 cm x 5 cm x 2.1 mm). It can be charged wirelessly to 95% power within 15 minutes and can work continuously for an hour while maintaining a relatively low temperature to avoid overheating. The whole system can connect via Bluetooth to a mobile device to precisely control and monitor the intensity of the electronic current that flows to the hand.

"WeTac has been successfully integrated into virtual and augmented reality scenarios, and synchronised with robotic hands through Bluetooth low energy communication," says Xinge. "Users can feel virtual objects in different scenarios, like grasping a tennis ball, touching a cactus, or feeling a mouse running on the hand."

The team is now working on expanding the patch's functionality so that it can also simulate feelings of heat and textiles. Communications are ongoing with industry for applications in the fields of entertainment, training and healthcare.

Credit: Dr Yu Xinge's research group | City University of Hong Kong

Using the user's hand sensitivity data, the new system provides a vivid and personalised touch experience in the virtual world.

Intelligent strategy

CONSULTANCY

Reach the next level in international communications.

Tell your story

CONTENT

Unleash the power of great content.

ARCH

Maximize engagement

Know who is interested

OUTREACH

Spread the word and reach more people.

MONITORING

Track coverage and build relationships.

THE COMPLETE SOLUTION FOR RESEARCH COMMUNICATIONS

asia RESEARCH NEWS

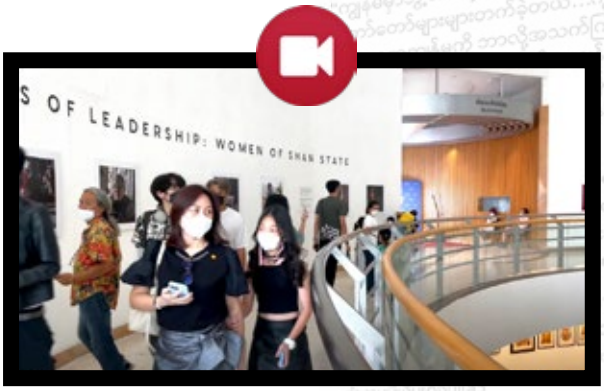
THROUGH EYES OF LEADERSHIP

IDRC's Knowledge for Democracy Myanmar (K4DM) initiative launched its second phase in Bangkok with a Knowledge Marketplace that brought together partners and stakeholders concerned about research and higher education in Myanmar.

Public visitors to the Bangkok Art and Culture Centre at the exhibition.

Further information | Knowledge for Democracy Myanmar (K4DM) initiative | myanmar@idrc.ca
k4dm.ca
International Development Research Centre

TOUR THE K4DM KNOWLEDGE MARKETPLACE EVENT



There is no democracy without gender equality and there is no gender equality without democracy.

Dr Khin Mar Mar

K4DM 2022 Bangkok

KNOWLEDGE MARKETPLACE

Exchanging Ideas for a Democratic Myanmar

In November 2022, the IDRC's Knowledge for Democracy Myanmar (K4DM) initiative launched its second phase in Bangkok with a Knowledge Marketplace event that brought together partners and stakeholders concerned about research and higher education in Myanmar to exchange ideas. The launch, which included a public photo exhibition at the bustling venue of Bangkok Art and Culture Centre, kick-started four years of online training, fellowship and support for research.

The events included book launches on the pre-coup stalled peace process and the situation after the coup. They also involved public discussion on the next steps to advance knowledge in Myanmar, and on federalism, peace and security, COVID-19 impact and recovery, climate change challenges and foreign aid. Research updates were provided on gender issues in the country, women's roles in the economy, democracy and social change and migration. Finally, workshops were held on effective writing, communications and digital research, and risk and safety in a post-coup environment.

Satellite partner events were also held in-person and virtually at Chiang Mai University and Mahidol University in Thailand.

K4DM is an initiative of the International Development Research Centre (IDRC) in partnership with Global Affairs Canada. Asia Research News and SEA Junction co-organized the Knowledge Marketplace with K4DM.

COMMUNICATING ABOUT LIFE BEYOND EARTH AND OTHER BIG NEWS

Finding extra-terrestrial life would transform how we view our place in the Universe, but reporting on the search for it poses challenges for scientists and the media.

> **Until now, we have set the public up to think there are only two options: it's life or it's not life.**

The tendency of the mass media to sensationalise and misreport scientific developments has prompted researchers at the Earth-Life Science Institute (ELSI) in Japan to explore best practices in communicating potentially ground-breaking research to the public. Their project, a partnership with Leiden University in the Netherlands, is largely inspired by a recent article by authors at NASA calling for a framework to be developed for reporting emerging evidence for life elsewhere.

In light of recent developments, including robotic exploration of planets in the solar system and the deep insights about exoplanets likely to come from the James Webb Space Telescope, the NASA team pointed out that "our generation could realistically be the one to discover evidence of life beyond Earth". They expressed concern that early results in the field might readily be taken to imply much more than the scientific observations support.

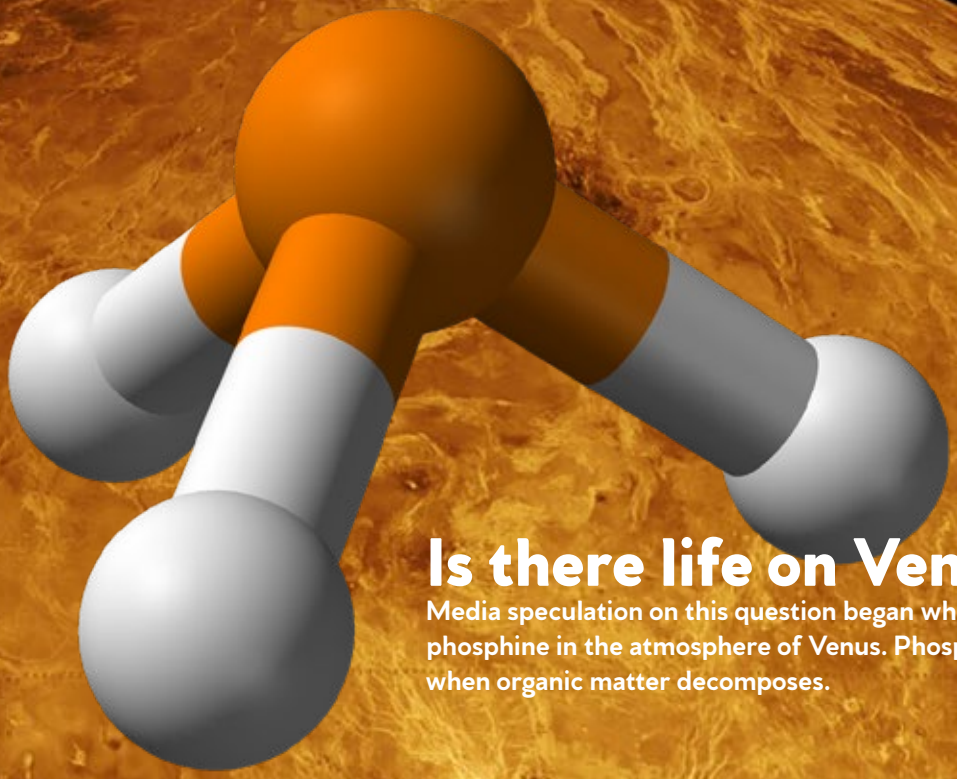
Yasuhito Sekine, director of ELSI, says such exaggeration and lack of caution had already occurred with a recent report suggesting that phosphine molecules had been detected in Venus's upper atmosphere, which might serve as an indicator of life. "Major news outlets jumped at the opportunity to report this exciting discovery," says Sekine. "But the claim was refuted by researchers a couple of days later, causing a stir within the research and media communities."

In their *Nature* article, the NASA researchers proposed a seven-level scale to guide how developments in the search for extra-terrestrial life should be widely communicated. The levels cover events ranging from provisional detection of possible evidence, through phases of checking for contamination or error, ruling out all possible non-biological causes, independent repetition of observations, and follow-up work as confidence in the evidence for biological origin increases.

Mary Voytek at the NASA Astrobiology Program, one of the authors of these proposals and a past ELSI executive director, explains: "Until now, we have set the public up to think there are only two options: it's

Credit: NASA/JP

Further information
Thilina Heenatigala | thilinah@elsi.jp
Earth-Life Science Institute (ELSI)
Tokyo Institute of Technology



Is there life on Venus?

Media speculation on this question began when some scientists reported phosphine in the atmosphere of Venus. Phosphine is typically released when organic matter decomposes.

Phosphine molecular structure model
Credit: pngwing.com

Credit: NASA/JP

life or it's not life. We need a better way to share the excitement of our discoveries and demonstrate how each discovery builds on the next, to bring the public and other scientists along on the journey without raising false expectations or even false alarm."

The Nature article stimulated interest across a wide variety of media outlets, which played a part in prompting the ELSI team to embark on their further exploration. They will work on this with Pedro Russo and Ionica Smeets at Leiden University.

The Leiden University-ELSI project is entitled 'We found life elsewhere in the universe: Future-ready science communication approaches.' Pedro Russo explains: "This research project will look at the most exciting of possible future news stories about the discovery of alien life, but it will also be relevant to the wider field of reporting scientific advances in general."

The research will most specifically examine the media's role in effective science communication and their contribution to the public understanding of the origin of life and astrobiology. It will also provide a more general framework, guidelines and best practices on communicating ground-breaking research results to the media and broader public.

"We will work closely with researchers, science communicators, journalists and the public, and each of these groups will participate in developing the framework for reporting evidence for life beyond Earth," says Thilina Heenatigala, ELSI communications director and a co-researcher on the project.

The earliest such evidence is likely to be indicative of primitive microbial life, if anything, but the research team is all too aware of the tendency for speculative findings in that area to be sensationally reported with talk of "aliens" and associated wilder sci-fi possibilities.

"We need a means to convey the preliminary nature of all scientific discoveries, the likely path of possibilities requiring confirmation and correction, and the sometimes rather stumbling and regularly corrected way in which science really works," says Heenatigala.

VENUS'S SURFACE FROM RADAR DATA This 3D image of Venus's surface was generated using radar data from NASA's Magellan spacecraft. The 3-kilometre-tall volcano Gula Mons can be seen on the horizon, along with the 48-kilometre-wide Cunitz crater at near-center.

BACTERIA POWER

Bacteria living on soil and chicken manure could provide low-tech and sustainable green electricity.

The natural activities of bacteria in soil mixed with chicken manure have been harnessed to generate electricity in a microbial fuel cell by researchers at Universiti Malaysia Sarawak (UNIMAS). Their work is published in the *Pertanika Journal of Science & Technology*. The innovation could become an inexpensive and simple source of electrical energy, especially in remote and less-developed areas, replacing more complex battery technologies.

"Our success is just part of our work at UNIMAS that is searching for methods to utilize natural resources for energy production," says UNIMAS electronic engineer Siti Kudnie Sahari.

The simple set-up used to demonstrate the system consists of a small plastic container with a cathode electrode sitting on top of the moist soil and chicken manure mixture, and an anode electrode buried inside it. As bacteria process natural chemicals in the mixture, they generate electrons that are collected by the anode and transferred as an electric current through an external circuit to the cathode. Each unit consists of a pot small enough to be held in the palm of the hand.

Early prototypes successfully generated electricity, but their output was too low to power even small domestic appliances. The team eventually overcame this limitation by experimenting with different electrode materials, including metals and various forms of carbon. Copper and zinc electrodes worked reasonably well, but the best option found so far uses highly porous "activated carbon" as both the anode and cathode.

Connecting four of the units together generates sufficient electricity to power an energy-efficient LED light of the kind that is becoming increasingly common for domestic use. The team also designed and added a component called a DC-DC boost converter that can increase the voltage and power density further.

Other researchers have also explored soil-based microbial fuel cells, but the power density achieved by the UNIMAS team, at 904 milliwatts per square metre, is the highest that any research group has reported to date.

The team is now working to refine the system and tackle some remaining challenges, including irregular electron flow between the electrodes. At present this prevents the system from maintaining a constant voltage. The researchers plan to develop a power management system that will enhance voltage levels and control to make the fuel cells suitable for powering domestic appliances.

"The initial achievement in lighting an LED demonstrates that our innovation could become commercially viable," Sahari concludes, adding: "One of the most significant benefits of microbial fuel cells is their ability to generate electricity from waste, so providing a novel option to concurrently treat waste while receiving a source of clean and renewable energy."

Credit: UNIMAS

Connecting four of the units together is enough to power an LED light. UNIMAS scientists hope the system could soon provide electricity to remote areas.

Credit: 123rf | simpson33

Assoc Prof Ts Dr Siti Kudnie Sahari | sskudnie@unimas.my
Faculty of Engineering
Universiti Malaysia Sarawak

Further information

AN INSTITUTE BRIDGING DIVIDES

Around the world, women are underrepresented in science, technology, engineering and mathematics.

In Japan, women rank below the Organisation for Economic Co-operation and Development (OECD) average. In first-year university classes before the pandemic, only 16% of physics students and 20% of mathematics students were women.[1]

It is thought that the low rates of women who go on to study these subjects is a result of the country's low level of gender equality, a stereotypical image by society that physics and mathematics are masculine subjects, and parents preferring daughters to not pursue advanced education.

But the 15-year-old Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU) is doing things differently. The official language at the institute is English, and half of its researchers come from abroad. Now, the institute's aim is to ensure a more diverse research culture.

Asia Research News met five female researchers to learn about their research, what drew them to Kavli IPMU, and their experiences there. These women, from diverse backgrounds, excel in their fields and show what can be achieved when women are not held back.

[1] Masculinity in the public image of physics and mathematics: a new model comparing Japan and England. Public Understanding of Science, 30(7), 810–826.

Further information
Motoko Kakubayashi | press@ipmu.jp
Kavli Institute for the Physics and Mathematics of the Universe
The University of Tokyo

Credit: KAVLI

MAN WAI CHEUNG: THE INTERPLAY OF MATHS WITH GEOMETRY

Mathematician Man Wai Cheung is the institute's first Chien-Shiung Wu Prize Postdoctoral Fellow, named in honour of the Chinese-American mathematician who made significant contributions to nuclear and particle physics. The fellowship covers three years with a research fund and annual salary, as well as other benefits, including support for fellows and their families to move to Japan.

Cheung's own research lies in the interplay between algebraic geometry, combinatorics and representation theory. Her main goal is to attain the mirror symmetries for cluster varieties. Mirror symmetry is motivated from mathematical physics to study dualities between geometries, the symmetry where information from one space can be obtained from another. Cluster varieties are spaces originated from algebras. Cheung is exploring the underlying link between these two subjects.

She obtained her undergraduate and master's degrees in her native Hong Kong and moved to the University of California, San Diego and Harvard for her PhD and postdocs. Working with other mathematical physicists and data researchers, she is also using data science to help solve these mathematical structures. This access to other researchers at Kavli and across Japan was part of the appeal of moving here.

Cheung has a side project in the new Center for Data Driven Discovery, to try to infuse data science into the structures she works on. "It isn't really my expertise, but the cluster varieties I study carry a lot of combinatorial structures, which is an area where mathematicians and physicists can work together to try to understand the significant properties of the structures," she says.

Although she has only been at Kavli for a short time, she already finds that the institute has a positive culture: "Senior faculty are very supportive and encouraging. They are distinguished and world class in their fields, and it's an honour to work with them."

Credit: 123rf | burakov

STORY CONTINUED

ELISA FERREIRA: THE UNIVERSE OVER TIME

Credit: KAVLI

Brazilian cosmologist Elisa Ferreira always knew she wanted to be a scientist, though she felt as a woman that she was encouraged into biology more than physics. In her last year of high school, a teacher suggested maths and physics and, realising she loved these subjects, changed her major while standing in line to hand in her form.

Ferreira studies the origins of dark matter and dark energy. She is developing new models and testing them by using astrophysical and cosmological observations to try to discover the nature of these mysterious entities, the hidden 95% of the Universe. She also looks at the Universe from immediately after the Big Bang, to understand its beginning and evolution and how our Universe looked like in its first moments, in order to explain what we observe at recent times.

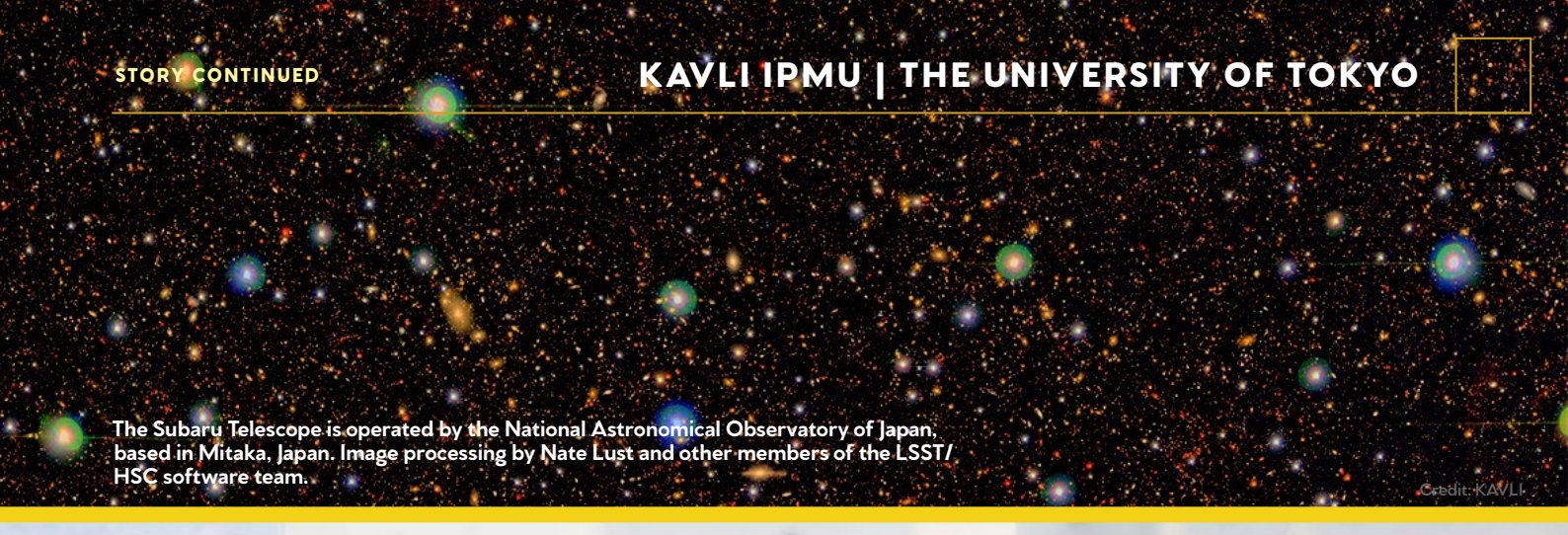
Her passion for cosmology is borne not only from a fascination about the Universe but also because cosmology is a subject that bridges a range of different areas of physics. As she puts it: "where everything meets everything."

Ferreira enjoys the interdisciplinary and collaborative environment at Kavli IPMU. This is not only an important aspect for all researchers, but it is also built into the architecture of the building and the ethos of the institute. The large sharing tables in the canteen and corridors that wind around the central piazza encourage interaction.

In her opinion, we should fight against stereotypes in the world of science as they are very damaging to young girls and minorities who are interested in science. She believes the stereotype of the sole genius scientist is inaccurate. "Science is collaborative. It is a collective endeavour. It is at the heart of successful research."

"I gain a lot as an individual but also for my research by talking to people and having others with different expertise in the same environment. That is the greatest thing you can have in research. Kavli IPMU has leading researchers from different research fields and a culture that invites collaboration. These are the main reasons why I chose Kavli IPMU."

Further information
Motoko Kakubayashi | press@ipmu.jp
Kavli Institute for the Physics and Mathematics of the Universe
The University of Tokyo



The Subaru Telescope is operated by the National Astronomical Observatory of Japan, based in Mitaka, Japan. Image processing by Nate Lust and other members of the LSST/HSC software team.

Credit: KAVLI

JIA LIU: SIMULATING MINI UNIVERSES

Jia Liu's route to cosmology was not straightforward. She obtained a BA in business management and an MA in human resources management in the US. Originally from China, her parents encouraged independence and exploration. Liu read about astronomy and quantum mechanics in her spare time while working for a consulting company analysing compensation data. Eventually, she realised this was where she wanted to place her full attention.

At Kavli IPMU, her research focuses on understanding fundamental parameters of the Universe, such as dark energy and dark matter, as well as tiny particles like neutrinos.

"We run simulations to understand the Universe at its beginning and how it evolved to where it is today, using many hundreds of mini universes with different initial conditions – some with more dark energy, others with more dark matter, and some with active neutrino particles," explains Liu. "We compare the final simulated universes to identify ones that are most similar to ours, and in this way we hope to understand how things began."

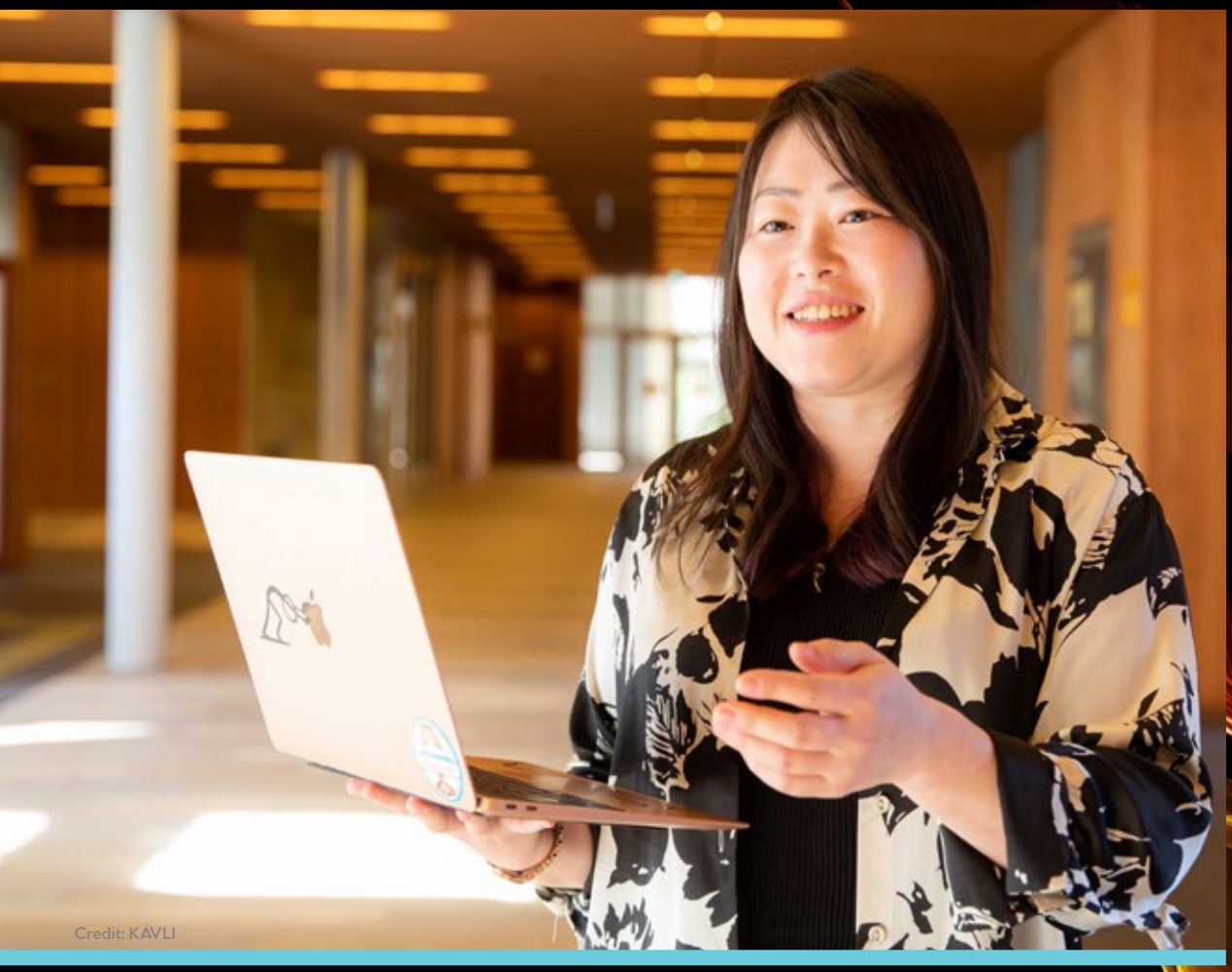
Faced with many offers, Liu chose to work at Kavli IPMU based on the advice of a supervisor who told her to pick the place she wanted to live and the people she wanted to dine with. As well as the new city and the friendly staff at Kavli IPMU, Liu has access to cosmic microwave background and galaxy surveys, which are often conducted separately. To her, this is the crux of the Kavli IPMU appeal: the collaboration, the meeting of disciplines, and the well-resourced community.

Liu has recently taken on the role of director of the new Center for Data-Driven Discovery, where she is implementing new data science techniques, such as machine learning. The work should help researchers analyse data more quickly.

Liu finds the use of machine learning to probe the fundamental parameters underpinning the workings of the Universe extremely satisfying. "I've been in this job for a year. Being asked to lead the center and to work across many disciplines with colleagues from across and beyond the institute is a true privilege. Kavli is really a good place to be a researcher at the intersection of so many positive things."

Credit: KAVLI

STORY CONTINUED



Credit: KAVLI

MIHO KATSURAGAWA: LOOKING OUT AND THEN IN

Miho Katsuragawa has recently shifted her focus from astrophysics to nuclear medicine, using X-ray and gamma ray detectors to look into cells.

Her PhD research at Kavli IPMU focused on the observational study of supernova remnants: what is left over after the explosion of an X-ray emitting star. Studying these X-rays makes it possible to observe star evolution over long periods of time.

Now she is developing X- and gamma-ray detectors for medical purposes using semiconducting devices. She explains that she uses the same equipment she used in her previous research to observe objects at a significantly smaller signal.

"We use the same device, which has high energy resolution, but the optical side is different. In medical imaging we want to see tremendously small things up close. We need to improve the imaging system, so we are collaborating with medical doctors. As physicists, we can develop the equipment and lead the experiments, but we need the medical researchers to understand the resulting images."

It is possibly because of the open and collaborative approach at the institute that Katsuragawa began to see that the devices she uses have applications in other fields, such as imaging, detection and nuclear medicine. She is now exploring other ways that they can be used in these areas.

Credit: 123rf | mermolenko

Further information
Motoko Kakubayashi | press@ipmu.jp
Kavli Institute for the Physics and Mathematics of the Universe
The University of Tokyo

EMILY NARDONI: INTERACTING QUANTUM RIPPLES

Emily Nardoni, a theoretical physicist originally from Los Angeles, California, also had a high school "aha!" moment when she realised that physics asks fundamental questions about the Universe and how it works. She grew up in Burbank, Los Angeles, USA, the movie studios town, surrounded by people who wanted to get into film. Despite choosing a different route, she had supportive teachers and forged her own path.

Her days are spent developing a deeper understanding of quantum field theory, the language of particle physics that describes all the elementary particles and forces as fluctuations of elementary quantum fields. She is focused particularly on where the ripples between various quantum fields are strongly interacting.

Nardoni finds Kavli IPMU a unique place that attracts international researchers from diverse fields. There is a vast amount of physics taking place in a dynamic and collaborative way, and one of its main strengths is its travel and visiting programme, which encourages researcher exchange visits.

"I can lead my own research programme, which I really like, especially at this stage in my career. Being encouraged to be independent and take the lead is pretty cool."

But above all, Nardoni highlights, "the focus on in-person interaction, collaboration and discussion is prioritised. They have chalkboards all over the building. So if I'm in some random hallway having a discussion with someone and we have an idea that we want to write down, we can go to a chalkboard two steps away."

Credit: KAVLI

WINDOWS GAIN COMPETITIVE EDGE OVER GLOBAL WARMING

An international collaboration is developing coating materials that could make windows better insulators.

A French–Japanese research collaboration has fabricated metal nanocomposite coatings that improve the insulating properties of window glass. The new coating prevents a significant portion of near-infrared (NIR) and ultraviolet (UV) rays from passing through, while at the same time admitting visible light. The findings were reported in the journal *Science and Technology of Advanced Materials*.

"Although the fabrication of a commercial product is still a long way ahead, our work demonstrated a significant improvement in UV and NIR blocking properties compared to previous research," says solid-state chemist Fabien Grasset, research director at the French National Centre for Scientific Research (CNRS).

"Buildings account for a large part of global energy consumption," he explains, "with a large amount of the annual energy consumption of a standard building going to cooling and/or heating systems to maintain indoor temperatures at comfortable levels."

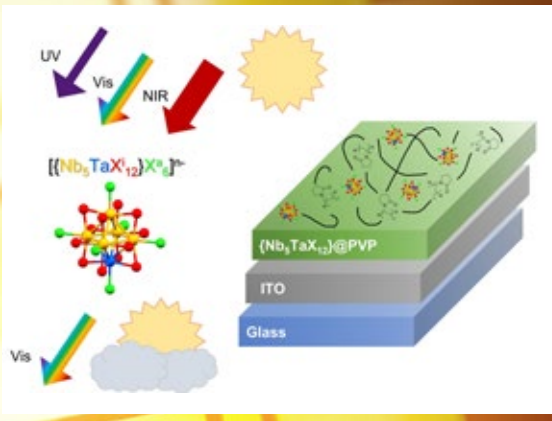
Scientists are looking for ways to develop window glass coatings that can block the entry of NIR radiation so that buildings, and even cars, can consume less energy to keep it cool inside. However, this needs to be done in a way that still allows visible light to enter. Ideally, harmful UV rays would also be blocked.

To this end, the international research collaboration fabricated and analysed the performance of nanocomposites based on niobium-tantalum cluster compounds containing chloride or bromide ions.

They found that chloride-based nanoclusters provided the best performance in terms of blocking NIR and UV rays and allowing the passage of visible light. NIR and UV blocking by the nanoclusters depended on their concentration, dispersion and oxidation state. By tuning these parameters, the team was able to improve the nanocluster performance.

The nanoclusters were dispersed into a polyvinylpyrrolidone (PVP) matrix that was then coated onto indium-tin-oxide (ITO) glass. "These are very promising coating materials that block the most troublesome NIR wavelengths," says Grasset.

"We have a long history of Japanese–French collaboration," he continues. "We were already convinced that we are stronger working together by mixing our different cultures and ways of thinking. The international LINK project has reinforced this belief. We will continue to do our best to make further progress towards finding solutions for the global warming problem."



The nanoclusters are dispersed in a PVP matrix that is then coated on ITO glass to block NIR and UV rays while letting visible light pass through.

Credit: 123rf | islander11

Dr Fabien Grasset | fabien.grasset@cnrs.fr
Research Director
French National Centre for Scientific Research (CNRS)

Dr Yasufumi Nakamichi | nakamichi.yasufumi@nims.go.jp
Science and Technology of Advanced Materials
National Institute for Materials Science

Further information

NURTURING GRADUATE STUDENTS WITH SCIENCE COMMUNICATION SKILLS

A science communication course at the Earth-Life Science Institute (ELSI) in Japan provides graduate students with practical skills to communicate research to a diverse audience.

Credit: ELSI

"Science is a multi-layered enterprise, where new and old information is being shared by a variety of stakeholders," says Thilina Heenatigala, ELSI's specially appointed assistant professor and director of communications. "This in- and outward communication between different layers is crucial for understanding and advancing science."

Heenatigala is a lecturer of the course "Communicating Earth-life science to the world", under ELSI's integrated five-year graduate program. It aims to equip graduate students with practical skills to communicate research to a scientific community, policymakers and the public.

Through lectures, discussions and projects, students learn answers to questions like what is science communication, how differently do scientists and the public understand research, and what are researchers' responsibilities in morals and ethics?

The course is led by Heenatigala, ELSI's vice director John Hernlund, and biogeochemist Shawn McGlynn, who bring in key skills and knowledge on public and media engagement, organising large-scale scientific meetings and outreach at an institution level, and building collaborations and dealing with academic decision makers.

"It was an interesting course where we learned different facets of scientific communication, like public engagement, scientific meetings, publishing scientific papers, and press releases," says Riddhi Gondhalekar, a graduate programme student who participated in the course.

Scientist-public relationship

Learning how to communicate science effectively at the start of a career helps young researchers in various ways. For example, it equips them with the skills necessary to present at a conference and build a network. "But most importantly, it helps them think of their scientific activities being connected to the society," Heenatigala says.

Heenatigala explains that students are "quite keen" to understand what science can give society, discuss how public outreach can be a means to return taxpayer investment in science, and scrutinise diversity, equity and inclusion in today's academia.

"While the course provides fundamental tools and skills for science communication, it is these discussions that drive students to become a responsible scientist in the future."

Not all science students are familiar

Further information
Thilina Heenatigala | thilinah@elsi.jp
Earth-Life Science Institute (ELSI)
Tokyo Institute of Technology

Students are keen to understand what science can give society, discuss how public outreach can be a means to return taxpayer investment in science, and scrutinise diversity, equity and inclusion in today's academia.

with the idea of studying communication. Nevertheless, collaborating with others and working on project-based assignments help them navigate the course.

"One of the students did a public lecture as part of the final exam and mentioned how rewarding it was to learn about effective public engagement," he says.

A new career path

Outside the course, students are encouraged to participate in ELSI's outreach activities and to join an organisation for science communicators. This provides an opportunity to learn from experts, create a network, and have a peek at careers in science communication.

One such group is the Japan Scicom Forum, an English-language-based community for people involved in international research outreach and is coordinated by Heenatigala and colleagues from different institutes.

The members, including press officers, researchers and students, meet at an annual conference, which was hosted by ELSI between 2018 and 2021, and also organise webinars with experts and hold other social events. "We also hope to provide research projects for interns in the future," Heenatigala says. The projects will be focused on Japan, such as evaluating science communication in the country and assessing public engagement at research institutions, science museums and centres.

Unlike in some other countries, science students in a master's or doctorate programme in Japan rarely receive science communication training or meet science communicators on the ground. Heenatigala says that ELSI took a "step forward" by adding a mandatory science communication course in the graduate programme.

"This lack of training is a major drawback for Japan, as we cannot produce science communicators, and science graduates do not have the option to go into the field."

ELSI wants to change this in the future. It is currently seeking to work with another university and offer a science communication course in English to anyone in Japan, including students, researchers and outreach staff.

"In the long term, the plan is to extend the science communication course into a graduate programme, called science communication and society, which covers master's and doctorate degrees," says Heenatigala.

SPEEDY SURFACE ANALYSIS FOR SEMICONDUCTORS

Machine learning algorithms allow analysis and characterization of the atomic arrangement of silicon surface superstructures without the need for human expertise.

The ever-advancing miniaturization of technology requires fine control and analysis of the structure of materials at the atomic scale. Researchers in Japan have now developed a machine learning technique to analyse semiconductor surface structure much more rapidly and simply. The work, led by Naoka Nagamura at the National Institute for Materials Science, is published in the journal *Science and Technology of Advanced Materials: Methods*.

Surfaces with precisely controlled atomic arrangements are generally made in a process called physical vapor deposition (PVD), in which the materials needed to build the surface are delivered in gas form in a vacuum chamber. The gaseous components condense into the solid phase as the required surface is created. Many different surface structure arrangements can be formed.

Analysing these "surface superstructures" is vital for monitoring the success of the PVD procedure, and for learning how to create the precise surfaces desired. The analysis is generally achieved by a process called Reflection High-Energy Electron Diffraction (RHEED), which records the diffraction of a beam of electrons fired at the surface at low angles.

However, highly skilled experts are needed to make sense of the complex diffraction pattern images that RHEED can produce. To address this, Nagamura and her team developed machine learning techniques that can help automate the data analysis.

The researchers investigated the appropriate computational algorithm for what they call "skill-agnostic analysis" by comparing several unsupervised learning methods.

Tests in which indium atoms were deposited on silicon revealed that their technique was able to estimate the optimal conditions for forming a variety of surface atomic configurations more accurately than the conventional RHEED approach.

"This is the first study to apply machine learning algorithms to complex diffraction patterns of surface superstructures," says Nagamura, adding that it relied on crucial input from masters degree student Asako Yoshinari. "Our findings will accelerate semiconductor research and hopefully lead to new and effective ways of using machine learning techniques for materials science."

The team now plans to adapt its methods for use in other systems, including metal crystals, sapphire, silicon carbide and gallium nitride. These are all currently exploited in a wide range of technical applications, including microchips, lasers and sensors.

"We will promote widespread uptake of our methods by developing open software and packages for others to use," Nagamura says.

> **This is the first study to apply machine learning algorithms to complex diffraction patterns of surface superstructures.**

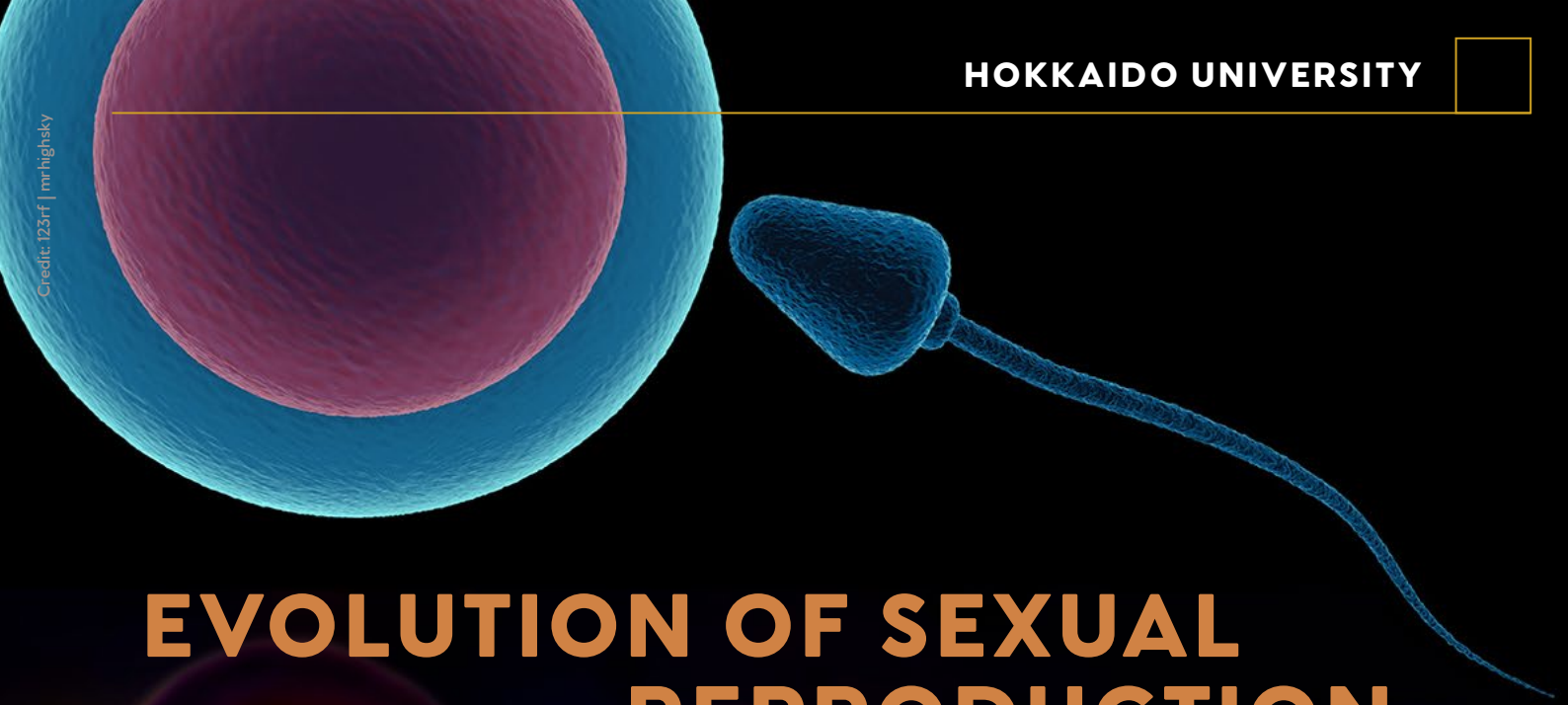
Credit: 123rf | pwstudio

Credit: 123rf | composite: zurijeta, perfectpixelshunter

Further information

Dr Naoka Nagamura | nagamura.naoka@nims.go.jp
Research Center for Advanced Measurement and Characterization
National Institute for Materials Science

Dr Yasufumi Nakamichi | nakamichi.yasufumi@nims.go.jp
Science and Technology of Advanced Materials
National Institute for Materials Science



Credit: 123rf | mrhighsky

EVOLUTION OF SEXUAL REPRODUCTION

Two novel hypotheses address the "two-fold cost of sex": one of the biggest enigmas in the evolution of sexual reproduction.

The evolution of sexual reproduction in living organisms is one of the biggest mysteries in biology. There are two known modes of reproduction: asexual, where the organism creates clones of itself, and sexual, where gametes from two individuals fuse to give rise to progeny. Many hypotheses address various aspects of the evolution of sexual reproduction, but many questions remain unanswered.

The biggest question is that of cost. Sexual reproduction requires exponentially more energy than asexual reproduction. Still, sexual reproduction has two major advantages: it leads to genetic diversity and reduces harmful mutations.

Now, two Japanese evolutionary biologists, Yukio Yasui of Kagawa University and Eisuke Hasegawa of Hokkaido University, have proposed and modelled two novel hypotheses to explain the two-fold cost of sex — the costs of meiosis, the type of cell division that produces gametes like eggs and sperm, and the cost of producing large numbers of male gametes. The hypotheses were published in the *Journal of Ethology*.

The seesaw effect

The first hypothesis suggests that the first sexual reproduction required only one individual and was a self-fertilizing event.

The story, as they see it, can be told as such: Sexual reproduction was preceded by an event in which asexual unicellular organisms containing two complete sets of chromosomes accumulated a nearly lethal amount of deleterious genes, known as dms. Since mutations occur randomly, dms genes were not distributed equally in the two genomes but were expected to be in a ratio around 30:70. The genome containing the smaller number of dms mutations is referred to as the clean genome C, while the other is called the dirty genome D. Then, a sex-controlling mutation, called allele S, occurred in the clean genome C. This first parent produced two cells capable of sexual reproduction that each had a clean genome carrying the allele S mutation. It also produced two asexual cells containing one dirty genome each. These latter cells died, while the former gametes fused with each other, fixing the sex-controlling mutation so that all offspring became sexual. At the same time, their deleterious dms gene numbers were reduced. The researchers refer to this as the "seesaw effect" because the upper hand went to the clean genome while the lower hand was dealt to the dirty one.

The rise of the sperm

The second hypothesis explains the cost of producing large numbers of male gametes. First, one must know that sexual reproduction in living organisms can be isogamous, where the gametes are all the same size, or anisogamous, where female gametes are large and male gametes are small and numerous.

The researchers propose that anisogamy developed via "inflated isogamy". The hypothesis suggests that sexually reproducing multicellular organisms that generate lots of energy evolved first. Increased resources in larger gametes improved the survival rate of their offspring, leading to an overall increase in gamete size, or inflated isogamy.

As the parental isogamete enlarged, the result of their fusion, the zygote, became larger than it needed to be. This led one sex, which later evolved into the male, to shrink its kind all at once, faster than the ability of both sexes to cooperate and gradually decrease their sizes together. The other sex, which evolved into the female, tolerated this change, as it had nothing to lose. The male gametes benefitted from this arrangement as their large numbers allowed them to fertilize the eggs of many females, while female fitness remained unchanged and the number of unfertilized eggs was reduced. Both sexes benefitted from this commensalism, and anisogamy and the two sexes evolved.

The two hypotheses are still in their initial stages, and further work is required to address some of their underlying assumptions and conclusions.

Credit: 123rf | drmicrobe

Assoc Prof Yukio Yasui | **yasui.yukio@kagawa-u.ac.jp**
Laboratory of Entomology
Kagawa University

Assoc Prof Eisuke Hasegawa | **ehase@res.agr.hokudai.ac.jp**
Laboratory of Animal Ecology
Hokkaido University

Further information

ASIA RESEARCH NEWS | 2023

ROBOTICS ENGINEERS PAY ATTENTION TO MATTERS OF THE HEART

A new apparatus uses electromagnets to remotely control guidewires through tiny, tortuous blood vessels for the treatment of cardiovascular diseases.

A multidisciplinary team of robotics and electronic systems engineers working with cardiologists and materials scientists has developed a robotic apparatus that uses an external magnetic field to precisely and remotely control guidewires through tiny and tortuous blood vessels. The team, led by researchers at Daegu Gyeongbuk Institute of Science and Technology (DGIST), reported their results in the journal *Advanced Healthcare Materials*.

The apparatus, following further tests and commercialization, could minimize the exposure of physicians to X-ray radiation while looking for and treating narrowed or blocked blood vessels.

"Cardiovascular diseases are the leading cause of death worldwide, and it is very important to be able to diagnose and treat these diseases in the most minimally invasive way possible," says DGIST robotics engineer Hongsoo Choi.

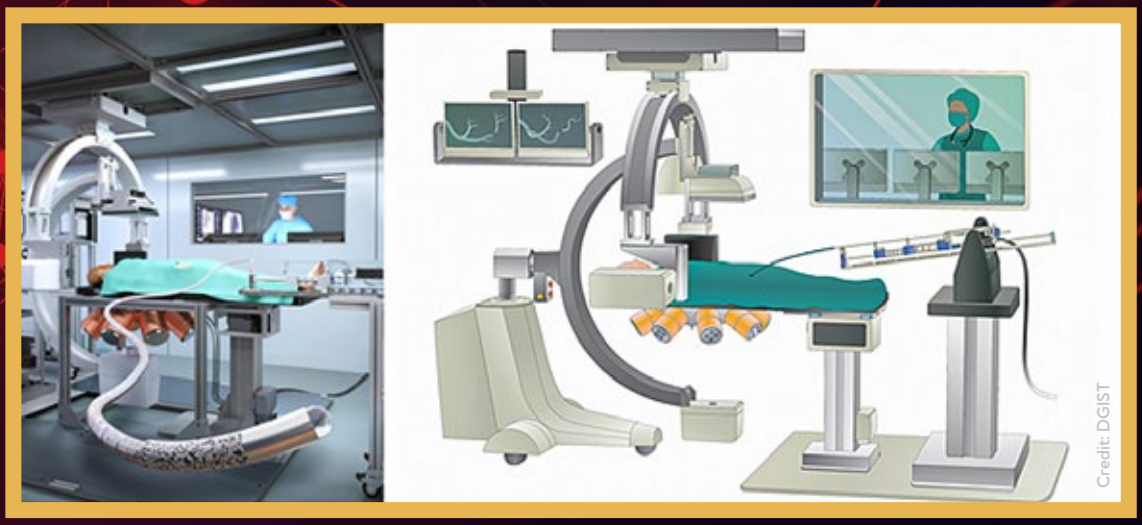
Currently, percutaneous coronary intervention (PCI) involves introducing a guidewire through the large femoral artery in the groin or the radial artery in the wrist and expertly manipulating it until it reaches the largest blood vessel in the body, the aorta. A contrast agent is then injected into the aorta, where it spreads into the coronary arteries that feed the heart. X-ray images are then taken to pinpoint any blockages present in these arteries. This intervention requires a huge amount of skill and can still lead to vessel perforation. It also involves unnecessary exposure of the physician to X-ray radiation, as the procedure is conducted at the patient's bedside.

In recent years, researchers have been investigating the use of robotic magnetic systems to improve the remote control of this sort of procedure. But the systems that have been developed are often bulky and do not respond quickly enough.

Credit: 123rf | nexusplexus

Further information
Prof Hongsoo Choi | mems@dgist.ac.kr
Department of Robotics and Mechatronics Engineering
Daegu Gyeongbuk Institute of Science & Technology (DGIST)

STORY CONTINUED



A new system consists of a magnetically steerable microrobotic guidewire and the eight electromagnets arranged in a hemispherical configuration under a surgical bed. By generating different magnetic fields with the electromagnets, the physician can remotely insert and control the guidewire into small and tortuous arteries from a separate X-ray-shielded control booth.

Now, Choi and his team have developed a system that involves remotely controlling a magnetically steerable microrobotic guidewire by applying a controllable external magnetic field. The field is generated by a system made of eight electromagnets arranged in a hemispherical configuration under a surgical bed. The patient is meant to be placed on the bed, with the guidewire inserted into an artery and guided remotely by changing the magnetic field. The guidewire is made of a biocompatible silicone tube that can move through blood vessels with very little surface friction. The tip of the microrobotic tube encapsulates a neodymium-iron-boron permanent magnet and hard-magnetic composites for magnetic steering.

The researchers first tested the system using 2D- and 3D-printed blood vessel models. They then tested it in anaesthetized pigs, managing to remotely control the guidewires through small and tortuous arteries in the pelvis, kidneys and heart.

"Our proposed electromagnetically controllable microrobotic interventional system (ECMIS) could reduce radiation exposure of physicians by empowering them to conduct the procedure remotely in an X-ray-shielded control booth using low-strength magnetic fields," says Choi. "It also does not require the high level of training needed for conducting conventional PCIs."

More tests and improvements are still required, but the researchers are already planning to further modify their apparatus so it can also target vessels in the nervous system and lungs.

Did you know?

Heart disease was the leading cause of death in Asia in 2019.

Heart disease deaths in numbers

- **18.6** million globally
- **10.8** million in Asia

The number in Asia rose from 5.6 million to 10.8 million between 1990 and 2019.

Source: Zhao D, et al. Epidemiological Features of Cardiovascular Disease in Asia. JACC: Asia. 2021 Jun, 1 (1) 1–13. https://doi.org/10.1016/j.jacasi.2021.04.007

LIGHTING UP ORGANIC SOLAR CELL RESEARCH

Modifying the active layer architecture at the heart of organic solar cells brings a big leap forward in efficiency.

Researchers at City University of Hong Kong (CityU) have found a way to significantly enhance the efficiency of carbon-based (organic) photovoltaic cells, commonly known as solar cells. The advance, reported in the journal *Nature Energy*, helps the drive towards cleaner and greener solar power systems known as organic photovoltaics (OPVs).

All photovoltaic systems use sunlight to generate electric current. Making them from organic molecules could offer advantages over the current silicon-based systems, including better material sustainability, low costs, light weight, physical flexibility and more readily renewable manufacturing processes. At present, unfortunately, OPV systems are not as efficient as existing options, with power conversion efficiencies of around 18% compared to 26% for silicon ones.

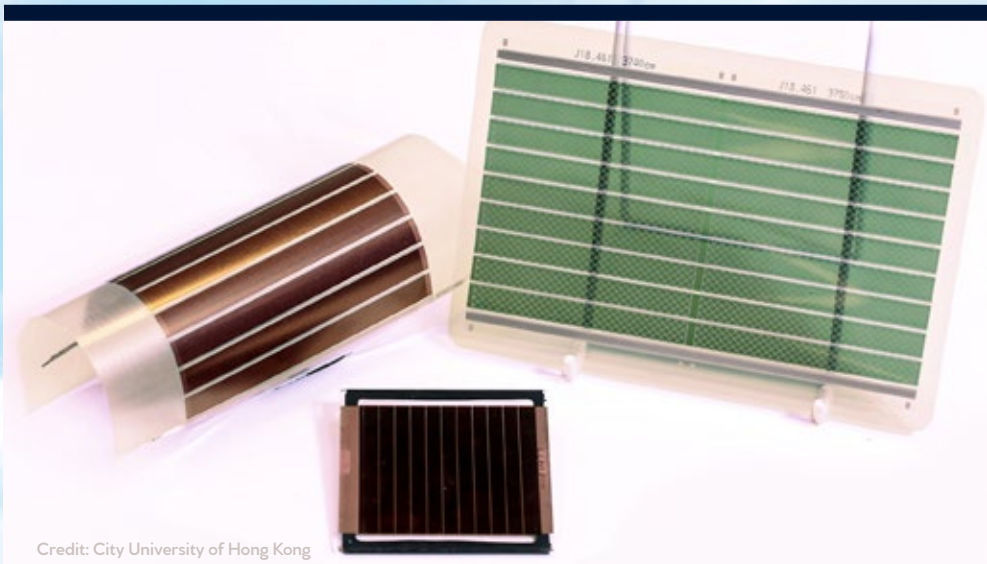
The initial key step in photovoltaic energy capture comes when sunlight causes a separation of electrically charged particles, generally by kicking a negatively charged electron out of a light-sensitive molecule. The separated charges eventually generate the electric power output of the system. OPV methods have suffered a problem, however, in which the separated charges can recombine before being efficiently collected to generate electricity.

"We have overcome this obstacle by inventing a novel device-engineering strategy to suppress the energy conversion loss, resulting in record-breaking efficiency," says CityU materials scientist Alex Jen Kwan-yue, who led the research team.

The key to the innovation lies in a crucial feature of the semiconducting OPV system called the heterojunction. This is where electric charge is transferred from donor to acceptor molecules. Until now, the donor and acceptors have generally been intermixed in a way called a "bulk-heterojunction" to facilitate separation of charges. However, this can also allow significant recombination of the separated charges, leading to power losses. The CityU team devised a different junction architecture, which is sequentially built up into a less well-intermixed arrangement. This suppresses the unwanted recombination of charges to an extent that has achieved conversion of solar to electrical power at efficiencies as high as 19%. The team expects to be able to move beyond 20% soon, which would take OPV systems into the realm of commercial feasibility. To support the transition from the lab to the market, they have now applied for a patent for their technology.

One interesting and unexpected technical finding from the research was that having fewer donor-acceptor contacts in the new planar-mixed heterojunction architecture improves performance. This fundamentally changes researchers' previous belief that more donor-acceptor contacts must lead to better performance. This insight could be important for driving research towards further improvements in OPV technology.

Francis Lin, another key member of the CityU research team, comments: "Our strategy should enable the development of OPVs that can compete with traditional inorganic photovoltaics, while benefitting from all the advantages offered by working with organic materials."



Credit: City University of Hong Kong

The new organic photovoltaics based on a rigid glass (centre), and light-weight plastic that provides mechanical flexibility (left) and even semi-transparency (right). The mechanical flexibility provides more options to harness solar energy, such as power-generating windows and wearable electronics along with traditional solar farms.

Further information
Professor Alex Jen Kwan-yue | alexjen@cityu.edu.hk
Lee Shau Kee Chair Professor of Materials Science
City University of Hong Kong

BLOOD AND SHELLS MAKE GREEN BATTERIES

Hi-tech electrocatalysts made from seashells and waste animal blood could help build sustainable batteries, fuel cells and other electrochemical systems.

Expensive and rare metals at the heart of modern electrical technology could be replaced by sustainable electrocatalysts derived from cheap and readily available waste biomass, thanks to researchers in Japan. The first examples have been made from a mixture of dried waste blood from the livestock industry and the readily harvested shells of the ascidian marine organisms known as sea pineapples.

"We have succeeded in making rechargeable zinc-air battery cells from this biomass-based approach," says Tohoku University materials scientist Hiroshi Yabu. His team worked with colleagues at Hokkaido University, Miyagi University and AZUL Energy, Inc. and reported their electrocatalysis advance in the journal *Science and Technology of Advanced Materials*.

The innovation centres on two chemical processes called the oxygen reduction reaction (ORR) and the oxygen evolution reaction (OER), which are crucial for the next generation of energy production and storage devices, including fuel cells and metal-air batteries. The ORR converts oxygen molecules (O_2) into negatively charged hydroxyl ions (OH^-). The OER reaction can split water molecules into oxygen and hydrogen, as required to exploit hydrogen as a sustainable fuel. At present, the electric charge needed to power these reactions must flow through a cathode containing materials such as platinum or iridium oxide as an electrocatalyst material. The electrocatalyst accelerates processes that would otherwise not proceed or would proceed too slowly to be useful.

The team in Japan are making alternative electrocatalysts from biomass resources that are much cheaper and more widely available than those based on rare metals.

The manufacturing process begins with a mixture of cellulose nanofibres, obtained from sea pineapple shells, and dried blood. This is heated in a vacuum at up to 900°C, in a process called pyrolysis, to generate carbon alloys. These carbon-rich materials incorporate varying small quantities of other elements, including nitrogen, sulfur, phosphorus and iron, which are crucial for determining the materials' electrocatalytic properties.

Tests with several mixtures and methods revealed that the best electrodes built from the carbon alloys could catalyse the oxygen reduction and oxygen evolution reactions as effectively as currently available metal-based catalysts.

"We didn't use any synthetic materials," says Yabu, "so our discovery could greatly assist the move towards a greener society and a more sustainable future."

To deliver on that promise, the team is now working to refine the materials and explore the scaling up and commercialisation steps that will incorporate them into a new generation of batteries and electrochemical, power-generating processes.

"We expect practical applications to be arriving within two years," Yabu says.

> **We didn't use any synthetic materials and expect practical applications to be arriving within 2 years.**

The sea pineapple (*Halocynthia roretzi*), usually found on rocks in shallow waters, and waste livestock blood were used to make rechargeable zinc-air batteries.

Assoc Prof Hiroshi Yabu | hiroshi.yabu.d5@tohoku.ac.jp
Advanced Institute for Materials Research (WPI-AIMR)
Tohoku University

Dr Yasufumi Nakamichi | nakamichi.yasufumi@nims.go.jp
Science and Technology of Advanced Materials
National Institute for Materials Science

Further information

A NEW AGE OF 2.5D MATERIALS

2.5-dimensional materials promise new applications for artificial intelligence, electronics, automobiles and the energy sector.

Scientists are exploring new ways to artificially stack two-dimensional (2D) materials, introducing so-called 2.5D materials with unique physical properties. Researchers in Japan reviewed the latest advances and applications of 2.5D materials in the journal *Science and Technology of Advanced Materials*.

"The 0.5D concept symbolizes the additional degree of freedom from the materials, composition, angles and space typically used in 2D materials research," explains nanomaterials scientist Hiroki Ago of Kyushu University in Japan.

2D materials, like graphene, consist of a single layer of atoms and are used in applications like flexible touch panels, integrated circuits and sensors.

Recently, new methods have been introduced to make it possible to artificially stack 2D materials vertically, in-plane or at twisted angles regardless of their compositions and structures. This is thanks to the ability to control the van der Waals forces: weak electric interactions between atoms and molecules, similar to how a microfibre cloth attracts dust. It is also now possible to integrate 2D materials with other dimensional materials, such as ions, nanotubes and bulk crystals.

A common method for fabricating 2.5D materials is chemical vapour deposition (CVD), which deposits a layer, one atom or molecule at a time, onto a solid surface. Commonly used building blocks for 2.5D materials include graphene, hexagonal boron nitride (hBN) (a compound used in cosmetics and aeronautics), and transition metal dichalcogenides (TMDCs) (a nanosheet semiconductor).

Using the CVD method, researchers selectively synthesized a bilayer of graphene, the simplest form of a 2.5D material, using a copper-nickel film with relatively high nickel concentration as a catalyst. Nickel makes carbon highly soluble, giving researchers more control over the number of graphene layers. When an electrical field was applied vertically across the bilayer of graphene, it opened a band gap, meaning that its conductivity can be turned on and off. This is a phenomenon that is not observed in monolayer graphene because it has no band gap and stays on all the time. By tilting the stacking angle one degree, scientists found that the material becomes superconducting.

Similarly, another group in the UK and the US found that a layer of graphene and hBN results in the quantum Hall effect, a conduction phenomenon involving a magnetic field that produces a difference of potential. Others showed that stacking TMDCs traps excitons – electrons paired with their associated holes in a bound state in the overlapping lattice patterns. This can lead to applications in information storage devices. New robotic assembly techniques have also made it possible to build more complex vertical structures, including a stacked heterostructure consisting of 29 alternating layers of graphene and hBN, for example.

Other research has used the nanospaces that form between the layers of a 2.5D material to insert molecules and ions in order to improve the electrical, magnetic and optical properties of the host material.

So far, for example, researchers have found that graphene stabilises iron chloride when it is inserted between its stacked layers, while inserting lithium ions leads to a faster diffusion rate – how quickly molecules spread in an area – than that of graphite, an electrical conductor used in batteries. This implies the material could be used in high-performance rechargeable batteries.

Further information

Dr Hiroki Ago | ago.hiroki.974@m.kyushu-u.ac.jp
Distinguished Professor of Global Innovation Center
Kyushu University

Dr Yasufumi Nakamichi | nakamichi.yasufumi@nims.go.jp
Science and Technology of Advanced Materials
National Institute for Materials Science

Future applications of 2.5D materials include solar cells, batteries, flexible devices, quantum devices, and devices with very low energy consumption.

Additionally, researchers found that inserting aluminium chloride molecules between two graphene sheets leads to the formation of new crystalline structures that are completely different from the bulk aluminium chloride crystal. More research is needed to understand why this happens and what applications it might have.

"There are many opportunities to explore with this new 2.5D concept," Ago says.

Future applications of 2.5D materials include solar cells, batteries, flexible devices, quantum devices, and devices with very low energy consumption.

The next steps should incorporate machine learning, deep learning and materials informatics in order to further advance the design and synthesis of 2.5D materials.

Japan's Ministry of Education, Culture, Sports, Science and Technology is now supporting this new concept to develop new materials under the collaborative project "Science of 2.5 Dimensional Materials: Paradigm Shift of Materials Science Toward Future Social Innovation", which involves 41 researchers in Japan, led by Ago.

Credit: xraycreative

VACCINES AND VITAMIN D: MEASURING IMMUNE RESPONSES

Researchers in Sarawak, Malaysia, measured the immunity responses of people who received different COVID-19 vaccines.

The rapid international effort to develop and deploy vaccinations against the SARS-CoV-2 virus has been a saving grace of the pandemic. But it's not over yet. Scientists now need to understand in detail how our immune systems respond to the different vaccines over time to continue to tweak them and improve their efficacy as the virus changes.

In a paper published in *Scientific Reports*, researchers at Universiti Malaysia Sarawak (UNIMAS) analysed blood samples of more than 300 vaccinees in the state of Sarawak. They tested for the appearance of various antibodies up to 13 weeks after receiving the second dose of two different types of vaccine: the Pfizer/BioNTech and Sinovac vaccines. Each vaccine uses a different approach to elicit an immune reaction. The Pfizer/BioNTech vaccine contains mRNA that codes for the spike protein present on the surface of the SARS-CoV-2 virus. When a person's cells start producing this protein, the immune system responds by forming antibodies that can recognize and bind to it, preventing the virus from attacking host cells. The Sinovac vaccine is made using whole inactivated virus, stimulating a broad immune response.

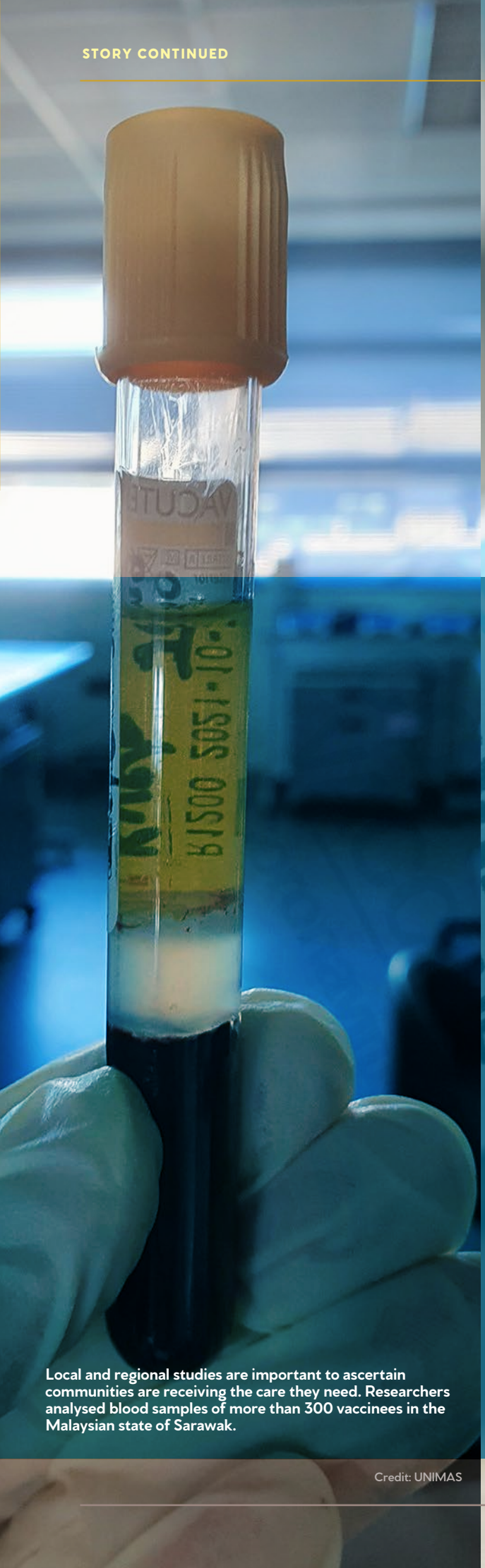
"We found that people who received the Pfizer/BioNTech vaccine produced significantly higher levels of antibodies that lasted longer compared to those who received the Sinovac vaccine," says UNIMAS virologist Cheng Siang Tan.

Malaysian national statistics show very low rates of intensive care admission (0.0066%) and death (0.01%) among people who received both doses of any vaccine. However, the statistics also show that, relative to Pfizer/BioNTech recipients, Sinovac vaccinees were more likely to require intensive care (5.5 times) or die (3 times).

Medical laboratory technologists Whilemena Upam (left) and Ummi Syafiqah (right) are preparing the blood for antibody testing.

Credit: 123rf | marchsirawit

Further information
Assoc Prof Cheng Siang Tan | cstan@unimas.my
Faculty of Medicine and Health Sciences
Universiti Malaysia Sarawak



Local and regional studies are important to ascertain communities are receiving the care they need. Researchers analysed blood samples of more than 300 vaccinees in the Malaysian state of Sarawak.

Credit: UNIMAS

Did you know?

Only 13.4% of the study population had sufficient vitamin D levels, despite being near the equator. Interestingly, the antibodies were not dependent on vitamin D levels.

Interestingly, the UNIMAS study found that a small percentage of people (1.9%) who received the Sinovac vaccine failed to produce antibodies against the virus's spike protein three weeks after the second dose, while 2.9% had very low antibody levels at week 13. "This could explain why COVID-19-related deaths are relatively higher among Sinovac recipients," says Tan.

The team also wanted to test whether vitamin D insufficiency has an effect on a person's ability to develop a strong immune response following vaccination against SARS-CoV-2.

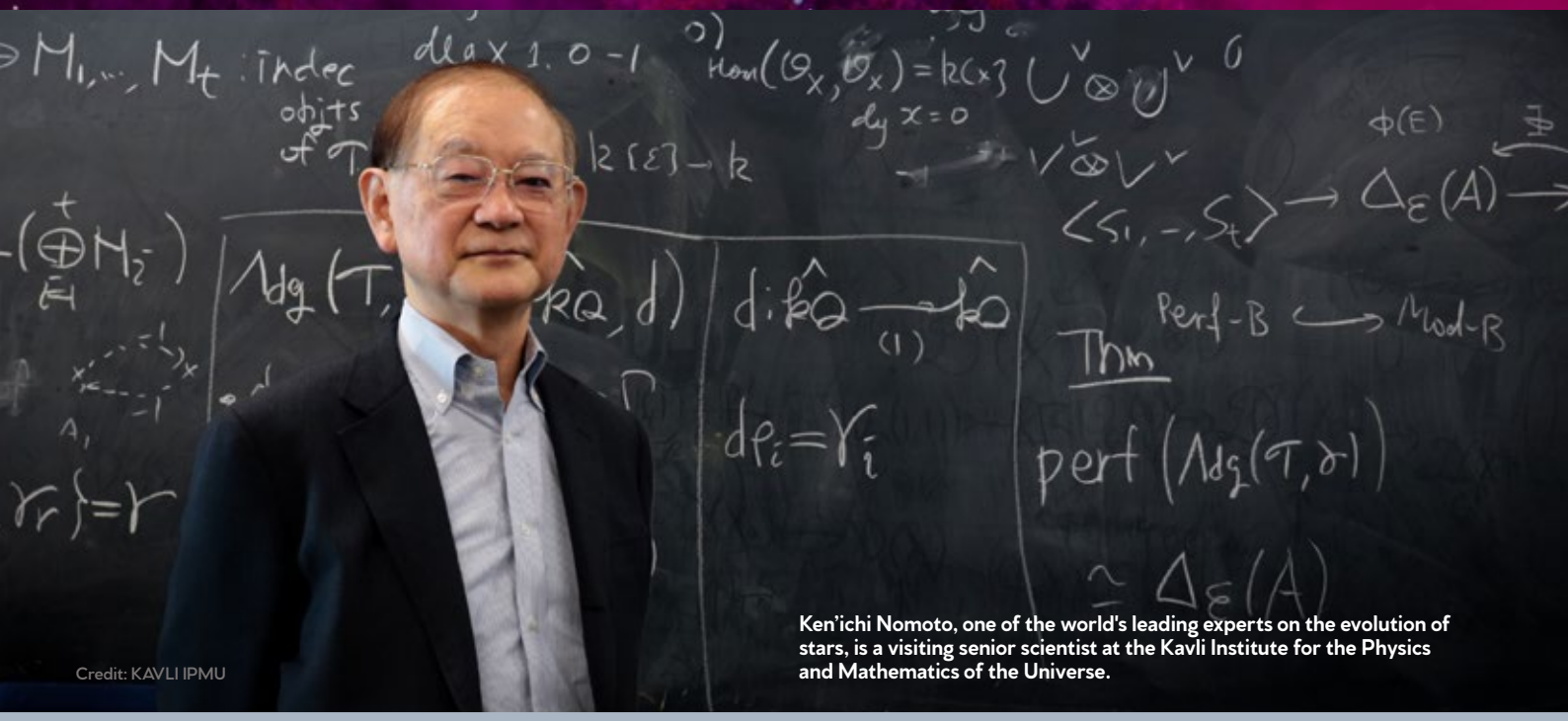
They were surprised to find that only 13.4% of the study population had sufficient vitamin D levels, despite Malaysia's location near the equator. This could be because people stayed indoors during lockdowns.

"Interestingly, we found that the magnitude and longevity of antibodies were not dependent on serum vitamin D levels," says Tan.

The team says its findings support a three-month interval between the second dose and the following booster of the Sinovac vaccine, but that recipients of the Pfizer/BioNTech vaccine, who have significantly higher antibody levels, could wait longer.

Next, the team plans to compare antibody responses in people receiving booster doses of the same or a different vaccine.

Read a related article from Asia Research News: ***Communicating vaccine research in a pandemic.***



Credit: KAVLI IPMU

Ken'ichi Nomoto, one of the world's leading experts on the evolution of stars, is a visiting senior scientist at the Kavli Institute for the Physics and Mathematics of the Universe.

AN UNEXPECTED JOURNEY

One astronomer never thought of leaving Japan, but then he did and became a world best.

Recipient of the Order of the Sacred Treasure by the Japanese government. Professor emeritus. Awards from academic organizations in the US, France and Italy, to name a few. It is safe to say that Ken'ichi Nomoto is regarded as one of the best experts in the world when it comes to finding out how stars evolve and how they end their lives in a dramatic explosion.

Nomoto, currently a visiting senior scientist at the Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU), has had his name appear on more than 200 papers since joining the institute in 2008 as one of its first members when he was a principal investigator.

While his academic career began long before the Kavli IPMU was established, Nomoto says today he is still researching the same thing he started studying when he was a university student in the 1970s, which is creating models for star evolution and supernovae, or star explosions.

"As a high school student I would go to talks by [radio astronomer] Takeo Hatanaka, and I read his book about star evolution.

"I was interested in physics, but I also liked history, so the word 'evolution' caught my attention. I combined stars and history. We're at the point now where we have the technology, like the James Webb Space Telescope, to study those first stars in the universe and how they formed."

Although Nomoto found his research area of expertise at a young age, he says he had never intended to become an international expert on the subject and had never even imagined going outside of Japan for his work. He says that the research grants academics relied on back then strictly prohibited the use of funds for overseas travel or hiring more researchers.

"There were no foreign researchers around at the time. I remember one time I was asked to host a researcher from Germany. I spent an entire day showing him around. Somehow we managed to communicate with one another, but by the end of the day I had a terrible headache."

That was not the only headache Nomoto encountered. Astronomer

Further information
Visiting Senior Scientist Ken'ichi Nomoto | press@ipmu.jp
Kavli Institute for the Physics and Mathematics of the Universe
The University of Tokyo

I was interested in physics, but I also liked history, so the word 'evolution' caught my attention. I combined stars and history.

Credit: KAVLI IPMU

Shock waves from a supernova produce enormous amounts of ultraviolet light. Analysing the UV light can reveal the explosion mechanism in a supernova.

Hatanaka passed away when Nomoto was an undergraduate student at the University of Tokyo, leaving him to look for a new mentor to help him pursue his interest in star evolution. But no one at the university was studying it.

Then, a chance meeting with astronomer Daiichiro Sugimoto, a protégé of pioneering astrophysicist Chushiro Hayashi, saved his academic ambition.

"Sugimoto was based in Nagoya University, but he taught at the University of Tokyo once a week. He would come into Tokyo on a Saturday, stay at the department's lodging room, and then go home the next day. He would stay up all night having discussions with the students before going back to Nagoya. And that's how we made a stellar evolution group at the university."

Discovering opportunities turned out to be Nomoto's ticket to furthering his career.

"In the beginning, I never thought of going overseas. I was scrambling to find a job. When I found a job at Ibaraki University, they happened to have a policy that allowed junior researchers to work overseas for a year or two on leave.

"At that time, Sugimoto had been at NASA for ten years, and he told me about postdoctoral positions there. I applied, and a few years later I was accepted to a position at the NASA Goddard Space Flight Center in Maryland."

Then began Nomoto's strategy of taking advantage of the opportunities in front of him.

"The good thing about NASA was that it was very broad. There was a host laboratory I was based at, but there weren't strict policies about what I had to do. So I thought, since I'm in the US, I'll start going to research meetings.

"They didn't give me money. A little maybe, but I remember writing letters everywhere to secure funding. If there was a conference, I would write a letter to the organizers asking for some travel funds."

As Nomoto traveled, he started promoting his work with NASA, which led to more opportunities.

This is an artist's impression of a white dwarf receiving gases from a binary companion star. Here researchers ran simulations to find out why supernova explosions of some white dwarfs produce so much manganese and nickel.

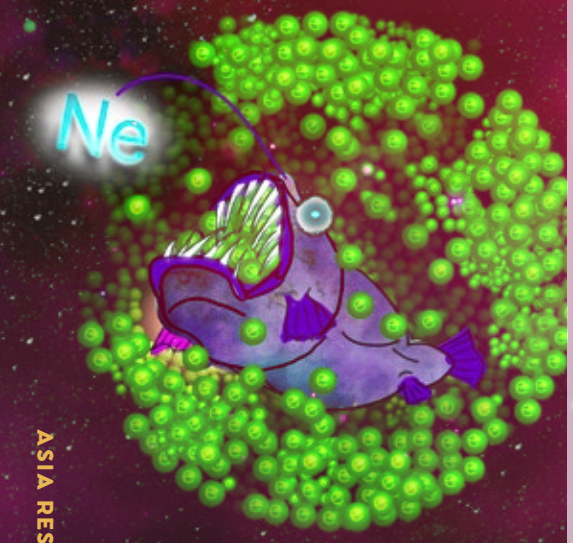
Credit: KAVLI IPMU

Astronomical objects are so many and so distant that you must be able to collaborate with other astronomers.

Scientists simulated the violent collisions between a supernova and its surrounding gas, which is ejected before an explosion, giving off an extreme brightness. This image shows a shock-interacting supernova with different velocity eruptions: the blue ring moves slowly, followed by the faster red-to-yellow gas.

Credit: KAVLI IPMU

Credit: KAVLI IPMU



Prof Nomoto and colleagues found that the neon in the very high density center of a certain massive star can eat so many electrons in the core that the star collapses into a neutron star, producing a supernova. This is an artist's impression of an imaginary deep-sea fish "football-fish" with a neon-sign eating away at the electrons inside a stellar core.

"I was studying how one type of supernova could produce lots of radioactive elements, which later helped find dark energy, and wrote a paper. A conference organizer in Italy read it and invited me to speak there. An American researcher from Stony Brook University heard my talk and invited me to apply for a one-year position at Brookhaven."

Two years later, at the Max Planck Institute in Germany, Nomoto's collaborative research involved studying gravitational collapses in explosions of very light stars.

But as Nomoto began to give talks, some people started criticizing his work.

"I would give a talk and someone would say I was wrong. But it's okay because then one of his collaborators would stand up for me."

From there, Nomoto found what worked best for furthering his research. The first thing was writing papers. The second was finding the gaps in the research, things that researchers in the US and Europe had missed, and filling in those gaps. In doing so, more people began to want to hear about Nomoto's work, and this led to being able to go to more conferences.

He also found institutes that offer short research stays.

"Astronomical objects are so many and so distant that you must be able to collaborate with other astronomers."

Over the years, Nomoto has seen Japan opening up to the international scene, triggering new research relationships that continue to this day.

"Allowing research funds to be used for international travel and for hiring researchers has been a game changer. It used to be that I had to leave the country to work with the best experimental researchers overseas to test my theories. Now experiments have become so much better in Japan that my rivals are traveling from the US to Japan to test their theories with Japanese experiments."


Behind every
breakthrough
there is a story.
It's time for Asia Research News to tell yours.
THE RESEARCH COMMUNICATION EXPERTS
asia
RESEARCH NEWS

asia
RESEARCH NEWS

Call for submissions 2024

WHERE RESEARCH STORIES ARE TOLD

Expertly written, beautifully designed.

asiaresearchnews.com