Osaka City University Official Magazine

CITY × UNIVERSITY

March 2018

Reseachers Special

Nobel Laureates

Dr. Yoichiro Nambu, Osaka City University (OCU) Professor Emeritus / Distinguished Professor Emeritus and winner of the 2008 Nobel Prize in Physics, became a member of the university's newly established Faculty of Science and Engineering in 1949. As a rising young professor he led a theoretical physics research group and lay the foundation of the current Graduate School of Science (Department of Physics). While he subsequently moved to Chicago, the free and open-minded research environment that he built still exists at OCU today. In 2011, the university awarded him with the title of OCU Distinguished Professor Emeritus. In 2017, the university established the Yoichiro Nambu Memorial Award for Young Researchers following the wish of late Dr. Nambu (passed away in July 2015) who always encouraged young researchers.

Dr. Shinya Yamanaka, Director and Professor of Kyoto University's Center for iPS Cell Research and Application and winner of the 2012 Nobel Prize in Physiology or Medicine, began studying at OCU in the doctoral program of the Graduate School of Medicine in 1989. He received a PhD in Medicine from OCU in 1993. After studying in the United States, he became an OCU faculty member of Medicine (Department of Pharmacology) until 1999 when he moved to Nara Institute of Science and Technology, and subsequently to Kyoto University.

Comments from Osaka City University Vice President in charge of Research

Hiroyuki Sakuragi

This pamphlet introduces two Nobel-prize winners closely connected to Osaka City University and seven outstanding researchers actively engaged in cutting-edge research in a variety of fields on the international stage. They're top-notch researchers working on the front lines of research fields from the basic science — astrophysics, molecular science, biology — to important issues directly connected to contemporary society, such as global business, the development of new energy sources, food science, medicine, health and sports science. Polishing up our human resources, Osaka City University will continue to reach new heights as a top-level research university.

Yoichiro Nambu

Shinya Yamanaka

Continuing to Explore the "Mystery of Photosynthesis"

How do plants produce oxygen? We found the molecular structure of "the manganese cluster", the key to solving the mystery of photosynthesis.

Professor Nobuo Kamiya

Advanced Research Institute
for Natural Science and Technology

Photosynthesis involves a process that produces glucose using solar energy and carbon dioxide (CO_2), the remains of the organic substances that are abundant on earth. Glucose is a nutrient from which almost all living organisms on the earth, including humans, obtain energy through respiration.

"Photosystem II" (PSII, Figure 1), which is a complex of 20 proteins in chloroplast, receives sunlight, decomposes water, and generates oxygen molecules as well as electrons. These electrons are used to convert CO_2 into glucose. It has been that the oxygen generation reaction of PSII proceeds on the metal-oxygen cluster (manganese cluster) consisting of four manganese (Mn) atoms and a calcium (Ca) atom linked by multiple oxygen (O) atoms, but the accurate chemical composition and detailed atomic arrangement of the cluster have remained unclear over the years.

Prof. Kamiya, in collaboration with Prof. Jian-Ren Shen of Okayama University, succeeded in dramatically enhancing the quality of PSII crystals and performed X-ray crystal structure analysis using SPring-8, a large synchrotron radiation facility in Nishi-Harima, Hyogo Prefecture.

This analysis revealed that the manganese cluster has the chemical formula of Mn_4CaO_5 arranged in the shape of a distorted chair, and two water molecules are associated with 1 Mn atom and the Ca atom. Parts of these four water molecules are thought to be incorporated into the oxygen molecules generated from the manganese cluster.

It is expected that the findings of this study will help find the mechanism by which solar energy is converted into chemical energy that can be used by living

organisms and will contribute to solving problems related to the global environment, energy, and food shortages.

For study findings of the researchers of the OCU Advanced Research Institute for Natural Science and Technology, including Prof. Kamiya, please see the following webpage:
http://www.ocarina.osaka-cu.ac.jp/index_e.html

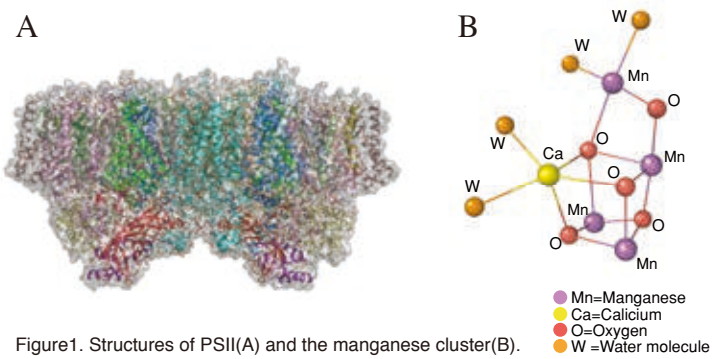
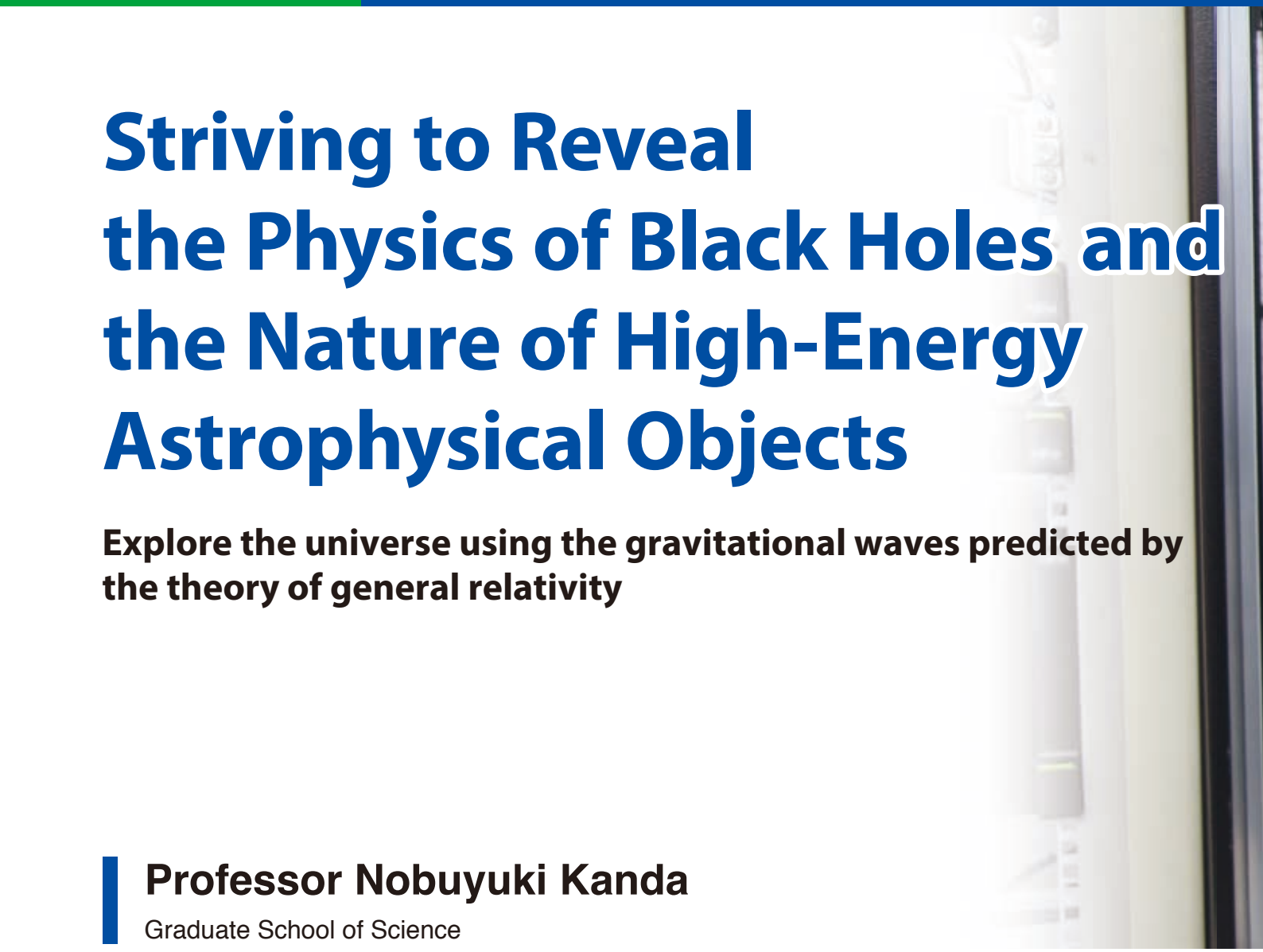


Figure1. Structures of PSII(A) and the manganese cluster(B).

Striving to Reveal the Physics of Black Holes and the Nature of High-Energy Astrophysical Objects

Explore the universe using the gravitational waves predicted by the theory of general relativity



Professor Nobuyuki Kanda

Graduate School of Science

The laboratory of Prof. Nobuyuki Kanda, Graduate School of Science, is the hub of analysis of observation data obtained from the KAGRA experiment in Japan. The goal of the Kanda Laboratory is to explore the nature of high-energy astrophysical objects that exist in large numbers in the universe by observing gravitational waves using the KAGRA detector.

In February 2016, the LIGO experiment (U.S.A.) reported that gravitational waves were detected by their two detectors for the first time in human history. The existence of gravitational waves (a phenomenon in which distortions of space-time propagate as waves at the speed of light) was originally predicted by Einstein's general theory of relativity. Since there had been no previous report of direct observation of gravitational waves, this represented a great achievement in the history of physics.

The Kanda Laboratory is responsible for analyzing the observation data from KAGRA. Data derived from the KAGRA laser interferometer in the Kamioka Mines in Gifu Prefecture are transmitted to the gravitational wave data analysis computer in our university campus within 3 seconds. Analyzing this data, we intend to capture the gravitational waves from weak signals.

Once we observe gravitational waves, we expect to be able to understand cosmic phenomena such as black holes, supernovas, gamma-ray bursts, neutron stars and the inflation of the universe.


Clustering System

Business Issues Are Society's Issues

An Insightful Business Scholar in a Pursuit of True Happiness for People through Business

Professor Jin-ichiro Yamada

Graduate School of Business

Professor Yamada's research themes are entrepreneurship and innovation. His aim is to explore these areas of knowledge from domestic and global perspective. The key to it is people. He gathers examples of knowhow and impressions from many people, including managers and executives, and continues with his analysis.

As a fervent educator who believes that it is his mission to send out into the world many talented individuals, Professor Yamada always asks his students "Why?", "What do you think?", and "What would you do?", and he also asks himself the same questions.

He values the belief in looking into the past to understand the future, and therefore, when thinking about business, he focuses on the type of growth that a company has achieved. In turbulent times for management, where a correct answer is difficult to be found, Professor Yamada visits many managers and executives in search of better solutions.

In order to conduct a vigorous research, you have to be active and to live with intense mobility. For example, when Professor Yamada was curious to learn more about outside directors, he took part in a joint project with a professor from SMU, Singapore. They conducted interviews with 60 outside directors and took notes of the differences in their background and the selection process for outside directors in Japan and the USA. They analyzed the relationship with the CEO with the human relationship being the key. Research continues on how those differences affect management.

Professor Yamada believes that business issues and society's issues are equally important, and he expects the business to have the power of innovation.

He is continuously interested in what kind of innovations entrepreneurs create and how those are returned to society and lead to happiness of people.

Solving the Unknown Power of Food Ingredients

Associate Professor Akiko Kojima

Department of Food and Nutrition,
Graduate School of Human Life Science

Prevention and improvement of outcomes of diseases are important and essential to achieving good health and longevity. Food ingredients have the potential to keep us in good health if we take advantage of their functions.

Good health and food are inseparable.

Substances contained in food are broken down in the body to supplement materials that make up the body and supply the energy necessary to maintain vital functions. In addition, food also contains mysterious ingredients that have important roles in maintaining good health.

On the other hand, excessive eating may lead to lifestyle-related diseases such as obesity, diabetes and arteriosclerosis.

In order to promote good health, it is very important to find the structures and working mechanisms of the regulators of vital functions. Finding them is our mission.

Hot Topic

We found that the primary ingredient of Thai ginger extract, 1'-acetoxychavicol acetate (ACA), has various physiological effects. Of particular interest is its effect of improving cognitive function. We are hoping to develop health food products containing ACA as the main ingredient to contribute to people's health.

Developing Energy to Support the Future

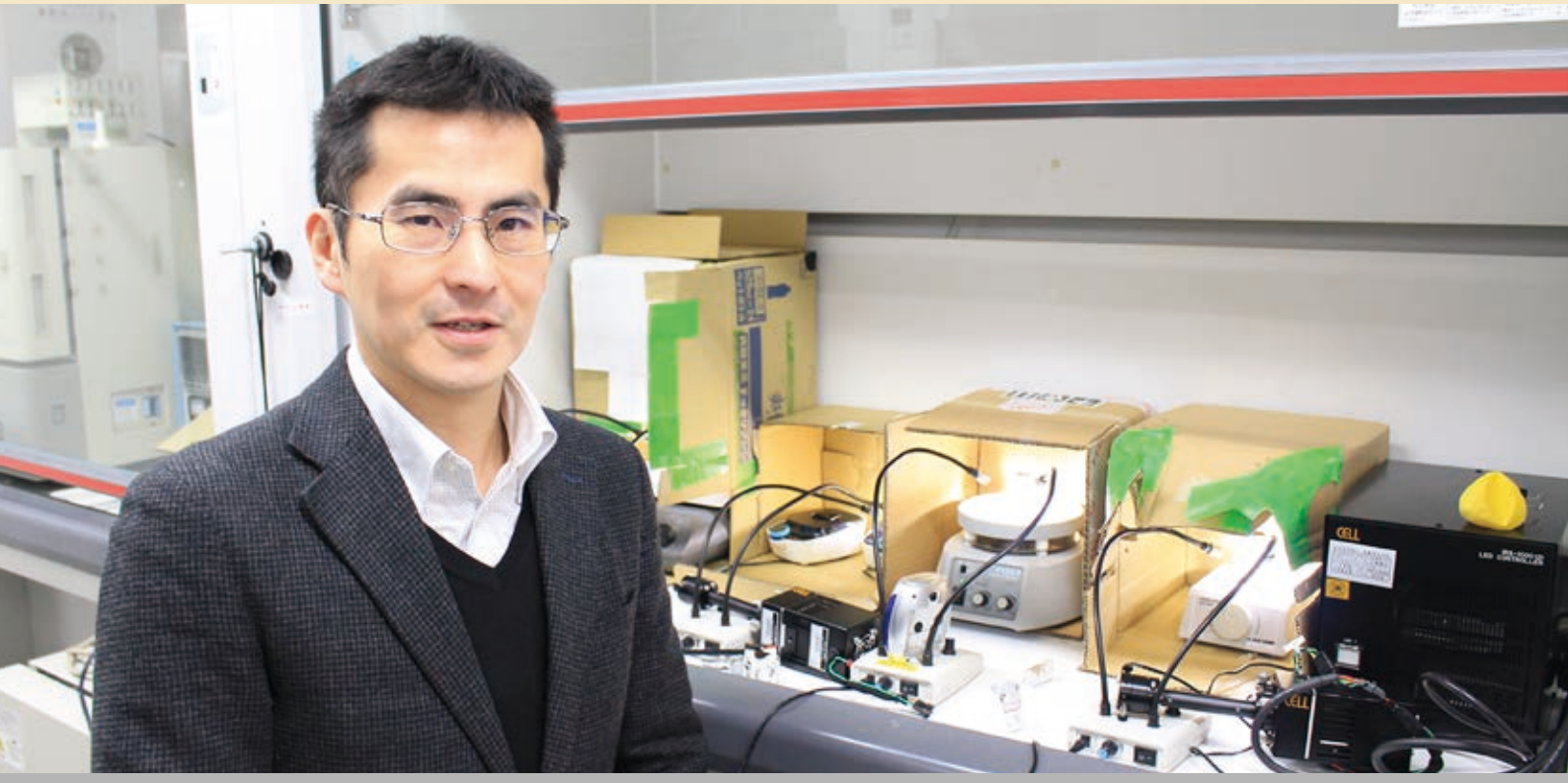
Developing catalysts to open the way to a sustainable society

Professor Yusuke Yamada

Department of Applied Chemistry and Bioengineering, Graduate School of Engineering

Utilization of environmentally-friendly clean energy such as hydrogen is essential to realize a sustainable society. The research team led by Professor Yamada addresses how to construct an efficient photocatalytic system to produce clean energy, so called solar fuel.

Effective use of solar energy is strongly demanded to realize a sustainable society. However, solar energy contains intrinsic drawbacks on storage, low power density, large fluctuations depending on time and seasons. These drawbacks can be overcome by converting the solar energy into chemical energy. Simply put, the conversion of solar energy into chemical energy is the process of using solar energy to produce high energy compounds from low energy compounds, such as water and carbon dioxide, as raw materials. This process is known as "artificial photosynthesis." We are currently working on developing an efficient artificial photosynthetic system.



The Endless Challenge to Improve Performance

Environmental physiological research from top athletes to the elderly

Professor Kazunobu Okazaki

Research Center for Urban Health and Sports

Training camps for Olympic athletes looking to establish world records go hand in hand with talking to local youths about the importance of exercise. Professor Okazaki is also enthusiastic about the interdisciplinary approach to researching firefighting gear worn by firefighters battling high heat at the site of fires and their body temperature. He is confronting the limits of the human body in terms of both field research and lab work.

Professor Okazaki was active as a mid- and long-distance runner and race walker until his fourth year at the university. Since becoming a researcher, he has used his athletic background to research mechanisms and strengthening methods to achieve advanced performance in various environments. As an example, in terms of thermalphysiology, increasing the intake of protein with specific timing has been confirmed to increase the blood volume and prevent a rise in body temperature even under harsh conditions. These research results have been well received, and Professor Okazaki contributes to the success of athletes as a physiology member of the scientific committee for the Tokyo Summer Olympics.

In addition, he is collecting and researching data on how to extend healthy life expectancy through research on preventing locomotive syndrome in elderly people and research on changes in how much junior high school students exercise and their development.

"Most people are interested in maintaining their health and show a temporary interest in various types of training. But as soon as a given method's popularity fades, it is forgotten. It is an extremely important mission to provide information to extend healthy life expectancy while confirming the scientific basis as to why constant exercise is necessary.

Confirming the Logical Thinking Ability in Fish

A discovery that overturns the conventional thinking about animal behavior

Julidochromis that attack each other

Professor Masanori Kohda
Graduate School of Science

A research group led by Masanori Kohda of the Graduate School of Science proved that logical thinking of the type "if A>B and B>C, then A>C" is possible for one type of fish. This discovery overturns the common thinking that "lower" vertebrate animals, including fish, only react to stimuli and perform simple learning.

Professor Kohda's research group focused on the tendency of Julidochromis cichlids that live in Lake Tanganyika in Africa to fight over territory. They proved that the logical thinking of "if A is stronger than B and B is stronger than C, then A is stronger than C" is possible even among fish.

Julidochromis is known to have the ability to identify individuals and exhibit subordinate behavior in which they flee from opponents against whom they have fought and lost. In an experiment, a group of three males of the same size was formed, and one fish was placed in a separate aquarium to observe the other two fish fighting in a separate aquarium.

The results confirmed that most individuals did not fight and exhibited subordinate behavior to those individuals who are stronger than another individual that beat them in a fight. Results of this and control experiments show that logically infer power relations, a discovery that overturns the common thinking that fish do not have complex cognitive abilities.

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