

Cutting-Edge Research in Kyoto University

Kyoto University is known for the quality and diversity of its research. Each issue of Research Activities can only highlight a small selection of those endeavors, but we hope to convey an impression of the university's rich academic milieu.

BIOL How Cells Build Up the Body

The amazing world of genes and cells during animal development.



A fertilized egg, the start of our life, divides repeatedly to produce many types of cells and tissues (heart, muscles, bones, brain, etc.). These developmental processes are regulated by the genetic program. Genes tell the cells what to do: some cells make up a tube-like structure (e.g. gut, lung, and spinal cord), and other cells undergo a long process to become neurons. Amazingly, cells “talk” to each other, and such cell-cell communications is important in the construction of the body. For example, neurons interact not only with muscles, but also with bones and blood vessels. Inter-cell communications is far more sophisticated than imagined. Dr. Takahashi and her colleagues are trying to understand how such communication is established at the molecular level through studies on chicken embryos. They say that they are continually amazed by the “beauty” in the process of animal development.

Dr. Yoshiko Takahashi

Professor, Graduate School of Science

www.zool.kyoto-u.ac.jp/labo/zoology04.html
develop.zool.kyoto-u.ac.jp/takahashi.html



MET Airflow Simulation at the Neighborhood Scale

Building-resolving model enables simulation of turbulent airflow in urban districts.

Simulation and forecasting of airflow at the neighborhood scale is a great challenge in atmospheric science and engineering. Dr. Takemi and his colleagues have developed a new approach to directly simulate turbulent airflow within urban districts, including around skyscrapers, by combining a numerical weather prediction model and a large-eddy simulation (LES) model. The LES model is an advanced fluid-dynamics computational model that explicitly includes the effects of buildings on airflow. This approach is capable of representing the turbulent nature of airflow within urban districts. Using very high resolution digital data of buildings, Dr. Takemi's group successfully simulated

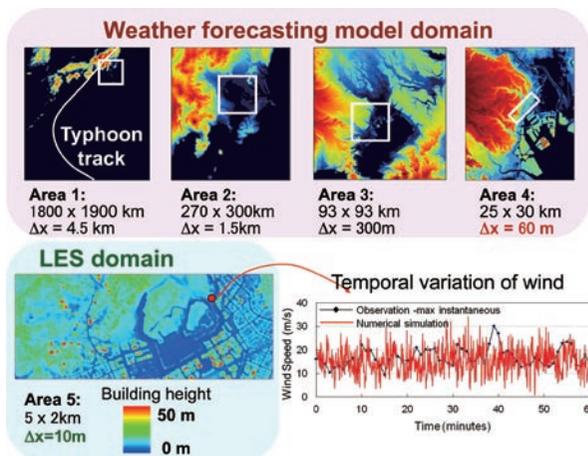
wind gusts during a typhoon passage in downtown Tokyo. The computational system can also be applied to air pollution simulation at the district scale.



Dr. Tetsuya Takemi

Associate Professor, Disaster Prevention Research Institute

ssrs.dpri.kyoto-u.ac.jp/~hp/index_en.html



CHEM Right- or Left-Handed!?

Optically active structures created by planar chiral [2.2]paracyclophanes.

[2.2] Paracyclophane has a unique structure consisting of two face-to-face benzene rings. Substitution of functional groups in [2.2] paracyclophane provides conformationally stable planar chirality. Dr. Morisaki has focused on planar chiral [2.2] paracyclophanes and created various optically active compounds using them as chiral building blocks. The obtained compounds form chiral second-order structures, such as 8-shaped, V-shaped, M-shaped, and helix structures. In other words, they form right-handed or left-handed structures. Some of them exhibit circularly polarized light (CPL) with unprecedented anisotropy factors: they emit right-handed or left-handed luminescence.



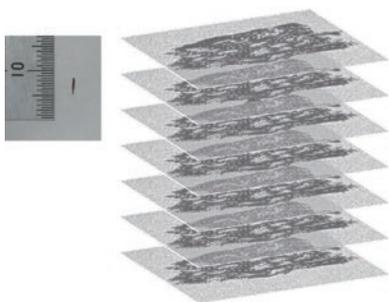
Dr. Yasuhiro Morisaki

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WOODSCI Wood is a Time Capsule!

Identification of wood used in culturally important artifacts.



The identification of wood used in historical and archaeological artifacts provides useful information about, and sometimes a new perspective on, the origin of the artifacts. Microscopic observation is a common method used to identify the materials used in wooden works, but it is not suitable for cases in which only a very small sample is available, as is always the case for artifacts of national heritage class.

Microcomputed tomography using synchrotron X-ray radiation, however, has tremendous potential for use in such studies. In addition to the benefit of its high spatial resolution, the nondestructive evaluation technique enables the reuse of the identified samples for chemical analysis,

including component analysis. Recent advances in the stable isotope analysis of wood to trace its geographic location will eventually allow us to determine the origin of such wooden artifacts, i.e. to determine when and where they came from.



Dr. Junji Sugiyama

Professor, Research Institute for Sustainable Humanosphere
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NEUROSCI How Do Social Influences Shape the Tweeting of Birds?

Unraveling the molecular mechanism of how neural systems are developed with social influences.

Songbirds tweet with each other using sounds woven into sequences, which are referred to as “songs.” Like human speech, their ability to communicate through songs has been developed with genetic and social influences. Dr. Abe studies the neural mechanism that enables songbirds to communicate with each other through vocal signals, and how such ability is acquired in postnatal development. By separately regulating intrinsic and extrinsic influences, and using his unique method to generate transgenic songbirds and instill songs under an experimentally controlled postnatal environment, he is now engaging in research to reveal how such ability is developed and plastically changed by postnatal experiences. Through an experimental approach, he seeks to provide insight into how human children acquire their own languages, which remains a mystery in the field of animal development.



Dr. Kentaro Abe

Senior Lecturer, Graduate School of Medicine
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PRIMATOLOGY Leopards Eat Chimpanzees?!

Predation pressure on our closest living relatives and its implication for human evolution.



A chimpanzee mother and infant (above) and a leopard (below) at Mahale

Evolutionary speaking, chimpanzees are the closest living species to humans, and it is therefore important to study their behaviors and ecology in order to gain an insight into human evolution. A research team at Kyoto University has been studying wild chimpanzees in the Mahale Mountains National Park in western Tanzania, for nearly half a century. Although Mahale chimpanzees are sympatric with leopards, there had been no evidence that leopards ate chimpanzees. However, when the team collected leopard scats from the forest floor and investigated its content, they eventually found some that contained chimpanzee bones. This is the first evidence that chimpanzees are actually eaten by leopards, not only Mahale chimpanzees but also the whole subspecies of East African chimpanzee. This may imply a potential predation pressure by large carnivores on great apes, and probably on our ancestral hominids.

Dr. Michio Nakamura (left)

Associate Professor, Wildlife Research Center

Ms. Nobuko Nakazawa (right)

Graduate Student, Wildlife Research Center

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OPT-SCI Femtosecond Laser Processing beyond the Diffraction Limit

Nanoprocessing of solid surfaces with ultrashort laser pulses.

Intense femtosecond laser pulses can produce self-organized, periodic nanostructures on solid surfaces. The size is typically 1/10-1/5 of the laser wavelength, which suggests that femtosecond lasers have the potential to sculpt structures smaller than the diffraction limit. Dr. Miyaji and his colleagues have shown that laser-induced near-fields and surface plasmon polaritons play a fundamental role in the nanoscale, periodic ablation of a surface. Through the ultrafast light-matter interaction processes controlled with the laser pulses, they have successfully fabricated a nanograting with a uniform period on a crystalline gallium nitride surface. It is expected that these results can be applied to a new class of versatile nanoprocessing techniques using femtosecond laser pulses.



Dr. Godai Miyaji

Assistant Professor, Institute of Advanced Energy

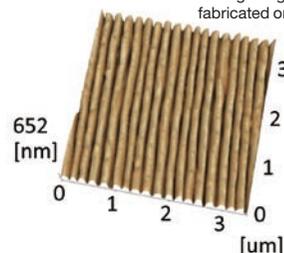
www.iae.kyoto-u.ac.jp/english/soshiki/laser.html



▲ Intense, ultrashort pulse laser system



▼ Nanograting fabricated on GaN



LAW “Bad” or “Mentally Ill” ??

Is the brain the criminal?

In criminal law, whether a person is deemed “criminal” or “mentally ill” depends on the existence of “free will” (which is denied to mentally ill people). German brain scientists have recently argued that the human brain determines all of a human being’s acts, and free will itself is, therefore, an illusion. This assertion implies that criminal law should be abolished. Could this hypothesis be true? Dr. Yasuda disagrees with this idea, asserting that human acts are connected to human brains and nervous systems, and follow causal principles.

The free will, a normative hypothetical construct, is compatible with these principles. Dr. Yasuda aims to analyze the conditions under which people can and should be responsible for their criminal acts.

Dr. Takuto Yasuda

Professor, Graduate school of Law
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A law court room in Japan

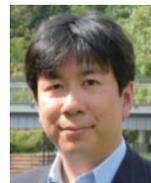


CHEM Inorganic Oxide Glass as a Candidate for Phosphors

Local structure design of inorganic glasses for future glass-based optical devices.

Light emitting devices and various kinds of phosphors are being actively developed recently. However, the host materials for those phosphors still remain limited with respect to a high-power or short-wavelength excitation light source. A transparent oxide glass possessing good chemical durability and exhibiting high emission intensity comparable to crystalline phosphor would be a novel emitting material capable of good formability. In addition, a random network of inorganic glasses allows diversity in composition and in local structure. Such diversity is the origin of various functionalities of inorganic glasses.

Dr. Masai and his colleagues demonstrated that transparent glasses containing Sn^{2+} center show a broad emission with a high value of quantum efficiency, comparable to conventional crystal phosphors. The emission can be tailored by changing the local coordination field of Sn^{2+} . Transparent inorganic glass phosphors will be a fascinating emitting material, which can be adopted as a strong light source in the future.



Dr. Hirokazu Masai

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HISTORY International Law and Sinocentrism

A study of Russo-Qing negotiations leading to the conclusion of the Treaty of Kyakhta.

In the first half of the 18th century, Russia and Qing China concluded the Treaty of Kyakhta which dealt with the border between the two countries and their diplomatic and economic relations. Almost three years (1726-28) passed from the commencement of negotiations to the signing of the treaty, and an agreement was reached only after much twisting and turning in the negotiations, with their venue being shifted from Beijing to the Bura River, near the Russian border with Mongolia in the process. The reason that the negotiations proceeded in such an irregular fashion was not so much that the positions of both parties were far apart, but rather that they both vied to take the initiative in setting the agenda, and the Qing stuck to Sinocentric thinking in its dealings with Russia, which was following international law. But once the Treaty of Kyakhta was concluded, East Asia enjoyed peace and stability for more than one hundred years.



Dr. Shigeru Matsuura *Professor, Graduate school of Human and Environmental Studies*

www.h.kyoto-u.ac.jp/staff/222_matsuura_s_0_e.html

PSYCH Culture and Happiness

Balance-Oriented Happiness in Japan.

Dr. Uchida, a cultural psychologist, has been engaging in empirical research on happiness, the meaning of which differs across cultures. She was a member of the Commission on Well-Being Studies of the Japanese government. It has been pointed out that Japanese score of happiness is lower than other industrialized countries, but Dr. Uchida found that the meaning of happiness in Japan has “yin and yang”—thus for example, their ideal level of happiness is as a 7 on a 10-point scale. Unlike European-American cultures, happiness in Japan is evaluated by taking into account the ups and downs of life

as a whole, and by “balancing” social relationships and harmony. Through these research findings on the cultural construction of happiness, Dr. Uchida aims to identify ways that the Japanese model of “balance-oriented happiness” could contribute to sustainability in the future society.



Dr. Yukiko Uchida *Associate Professor, Kokoro Research Center*

kokoro.kyoto-u.ac.jp/en/cultureko_net/index.html

Culture and happiness	
JP dialectic model relationship	U.S. incremental model Personal achievement
Calmness	Elation, excitement
Balance between positive and negative	Incremental view
Relationship harmony Emotional	Self-esteem Personal goal attainment
Social comparison	Personal choice