Press Release

June 14, 2024
INAMORI FOUNDATION

The 2024 Kyoto Prize Laureates Announced

The Inamori Foundation (President: Shinobu Inamori-Kanazawa) is pleased to announce the laureates of the 2024 Kyoto Prize, an international award presented to individuals who have contributed significantly to the scientific, cultural, and spiritual betterment of humankind. The prize presentation ceremony will be held on November 10 at the Kyoto International Conference Center. Each laureate will receive a diploma, a Kyoto Prize medal (20K gold), and prize money of 100 million yen per category.

Advanced Technology Prize Field: Materials Science and Engineering

John Pendry | Theoretical Physicist

Professor of Theoretical Solid State Physics, Imperial College London

Contribution of the Theoretical Construction of Metamaterials to the Field of Materials Science

John Pendry theoretically demonstrated that materials with electromagnetic properties not found in nature, such as negative-refractive-index materials (metamaterials) can be realized by designing microstructures smaller than the wavelength of the target electromagnetic waves, thereby laying the groundwork for creating innovative materials such as "superlenses" with subwavelength resolution and "invisibility cloaks."

Basic Sciences Prize Field: Earth and Planetary Sciences, Astronomy and Astrophysics

Paul F. Hoffman | Geologist

Adjunct Professor, University of Victoria
Sturgis Hooper Professor of Geology, Emeritus, Harvard University

Proving Snowball Earth Accelerating Life Evolution and Plate Tectonics Dating Back to the First Half of Earth's History

Based on geological evidence obtained over 50 years of extensive and precise field research in Arctic Canada and Africa, Paul F. Hoffman has accomplished landmark achievements regarding snowball Earth and plate tectonics in Earth's early history that led to the present surface environment teeming with diverse life.

Arts and Philosophy Prize Field: Theater, Cinema

William Forsythe | Choreographer

The Choreographer Who Opened a New Horizon of Performing Arts by Radically Renewing Methodologies and Aesthetics of Ballet and Dance

William Forsythe radically questions and deconstructs the structure and style of traditional ballet to create new methodologies and aesthetics of theatrical dance. He continues to go beyond the conventional concept of choreography and to extend the potential of the art form using human bodies through various innovative works.

BIOGRAPHY OF THE 2024 KYOTO PRIZE LAUREATE IN ADVANCED TECHNOLOGY

Prize Field: Materials Science and Engineering

John Pendry

Theoretical Physicist

Affiliation and Title/Position	Professor of Theoretical Solid State Physics, Imperial College London

Brief Biography

1943	Born in Ashton-under-Lyne, U.K.
1969	Ph.D. in Solid State Theory, University of Cambridge
1969–1975	Research Fellowship in Physics, Downing College, University of Cambridge
1969–1971	ICI Postdoctoral Fellow
1972–1973	Member of Technical Staff, Theoretical Physics Department, Bell Telephone Laboratories (currently Nokia Bell Labs)
1973–1975	Senior Assistant in Research, Cavendish Laboratory, University of Cambridge
1975–1981	Senior Principal Scientific Officer, Head of Theory Group, Daresbury Laboratory, U.K. Science and Engineering Research Council
1981–	Professor of Theoretical Solid State Physics, Imperial College London

Selected Awards and Honors

1996	Paul Dirac Medal and Prize, U.K. Institute of Physics
2004	Knight Bachelor
	Celsius Lecture, Uppsala University, Sweden
2005	Descartes Prize, E.U.
	Bakerian Medal and Lecture
2006	Royal Medal
2009	UNESCO-Niels Bohr Gold Medal
2013	Isaac Newton Medal and Prize, U.K. Institute of Physics
2014	Kavli Prize in Nanoscience
2016	Dan David Prize in Future: Nanoscience
	Ugo Fano Gold Medal

Memberships:	American Academy of Arts and Sciences, American Physical Society, National Academy of Sciences, Norwegian Academy of Sciences and Letters, Optica, Royal Society, U.K. Institute of Physics

ACHIEVEMENTS OF THE 2024 KYOTO PRIZE LAUREATE IN ADVANCED TECHNOLOGY

Prize Field: Materials Science and Engineering

John Pendry

Contribution of the Theoretical Construction of Metamaterials to the Field of Materials Science

The artificial design of materials with tailored electromagnetic properties is difficult because such properties are typically determined by the crystal structure and electronic configuration of a material. However, John Pendry's theoretical work showed that metamaterials (materials with unique electromagnetic properties that do not exist in nature and have not been experimentally explored) can be created by designing structures smaller than the wavelength of the electromagnetic waves of interest. Specifically, he showed that utilizing the resonant states of small structures with respect to electromagnetic waves enables negative permittivity in materials consisting of metallic wire arrays (1) and negative permeability consisting of nonmagnetic conductor split ring structures (2). Furthermore, he demonstrated that materials composed of both wire arrays and split ring structures simultaneously exhibit negative permittivity and negative permeability (3). Although in the 1960s, materials with both negative permittivity and permeability were predicted to have a negative refractive index, Pendry succeeded in constructing a theoretical framework to design such materials. Shortly thereafter, based on his theory, metamaterials exhibiting negative refractive indices were experimentally realized for the first time.

The fundamental concept underlying Pendry's metamaterials, based on which novel electromagnetic properties arise from structures on scales smaller than the wavelength, expands the possibilities for adjusting the properties of the material. For instance, negative refractive materials exhibit unique properties such as refracted waves at interfaces propagating opposite to the incident waves. Leveraging these properties of negative refractive metamaterials, Pendry proposed the concept of a "superlens" (perfect lens) that can achieve ideal infinite resolution without limitations arising from diffraction boundaries (3). The development of various devices using these lenses, including subwavelength microscopes, is currently being vigorously pursued worldwide. Furthermore, Pendry introduced "transformation optics," using coordinate transformations in Maxwell's equations to control the paths of electric fields, magnetic fields, and energy flows (4). This concept has considerably enhanced the design flexibility of optical components and has been applied in the design of various metamaterial devices. Notably, his proposal of an "invisibility cloak" that utilizes the design flexibility of the electromagnetic properties in metamaterials to reroute light around a shielded area and force it to its original path, effectively rendering the area invisible, has attracted widespread attention from both the academic community and general public. In collaboration with an experimental research group, Pendry has successfully demonstrated this property with the use of artificially structured metamaterials at microwave frequencies (5).

Pendry's research has led to considerable advancements in metamaterials research worldwide since the early 2000s. Metamaterials are expected to have various applications in microwave control, heat shielding, optical, and optical communication technologies. They are also applied to wave fields other than electromagnetic ones, such as acoustics. Thus, Pendry's innovative theoretical research on metamaterials has considerably advanced the field of materials science, created new interdisciplinary research areas, and paved the way for the development of novel materials with widespread social applications. His achievements are highly esteemed.

References

(1) Pendry JB *et al.* (1996) Extremely Low Frequency Plasmons in Metallic Mesostructures. *Phys. Rev. Lett.* **76** (25): 4773–4776.

(2) Pendry JB *et al.* (1999) Magnetism from Conductors and Enhanced Nonlinear Phenomena. *IEEE Trans. Microw. Theory Tech.* **47** (11): 2075–2084.

(3) Pendry JB (2000) Negative Refraction Makes a Perfect Lens. *Phys. Rev. Lett.* **85** (18): 3966–3969.

(4) Pendry JB, Schurig D, & Smith DR (2006) Controlling Electromagnetic Fields. *Science* **312**: 1780–1782.

(5) Schurig D *et al.* (2006) Metamaterial Electromagnetic Cloak at Microwave Frequencies. *Science* **314**: 977–980.

BIOGRAPHY OF THE 2024 KYOTO PRIZE LAUREATE IN BASIC SCIENCES

Prize Field: Earth and Planetary Sciences, Astronomy and Astrophysics

Paul F. Hoffman

Geologist

Affiliation and Title/Position	Adjunct Professor, University of Victoria, Sturgis Hooper Professor of Geology, Emeritus, Harvard University

Brief Biography

1941	Born in Toronto, Ontario, Canada
1968–1969	Lecturer, Franklin & Marshall College
1969–1985	Research Scientist, Geological Survey of Canada
1970	Ph.D. in Geology, Johns Hopkins University
1971–1972	Lecturer, University of California, Santa Barbara
1974–1975	Sherman Fairchild Distinguished Scholar, California Institute of Technology
1978	Visiting Professor, The University of Texas at Dallas
1985–1992	Senior Research Scientist, Geological Survey of Canada
1990	Visiting Professor, Lamont-Doherty Geological Observatory (currently Lamont-Doherty Earth Observatory), Columbia University
1992–1994	Professor of Geology, University of Victoria
1994–2008	Sturgis Hooper Professor of Geology, Harvard University
2009–	Sturgis Hooper Professor of Geology, Emeritus, Harvard University
2011–	Adjunct Professor, University of Victoria

Selected Awards and Honors

1992	Logan Medal, Geological Association of Canada
1997	Willet G. Miller Medal, Royal Society of Canada
2000	Henno Martin Medal, Geological Society of Namibia
2001	Alfred Wegener Medal
2009	Wollaston Medal
2010	Walter H. Bucher Medal
2011	Penrose Medal
2012	Order of Canada
2016	Gold Medal, Royal Canadian Geographical Society

Memberships:	American Academy of Arts and Sciences, American Association for the Advancement of Science, American Geophysical Union, Geological Association of Canada, Geological Society of Namibia, National Academy of Sciences, Royal Society of Canada, The Geological Society of America, The Geological Society of London

ACHIEVEMENTS OF THE 2024 KYOTO PRIZE LAUREATE IN BASIC SCIENCES

Prize Field: Earth and Planetary Sciences, Astronomy and Astrophysics

Paul F. Hoffman

Proving Snowball Earth Accelerating Life Evolution and Plate Tectonics Dating Back to the First Half of Earth's History

Through the accumulation of extensive and high-resolution field surveys for over 50 years, Paul F. Hoffman has made groundbreaking achievements regarding two significant factors, snowball Earth (global freezing) and plate tectonics in the deep past, which have formed the surface environment of the Earth, now teeming with diverse life.

By the late 1980s, several lines of evidence emerged that glaciers existed around the equatorial region approximately 600 million years ago. A possible explanation, the "snowball Earth" hypothesis, was proposed in 1992, which assumed that the Earth's surface was fully covered with ice. However, this bizarre scenario appeared unrealistic to many researchers, thus academic circles paid it little attention. It seemed impossible for the Earth to return to warmer conditions following a fully frozen state. Such a long-term total freezing would eventually lead to total life extinction. Hoffman has conducted geological surveys in Namibia, Africa, since 1993, where he investigated similar glacial deposits of the same age, which are capped by abnormally thick carbonate strata (cap carbonates) that are essentially deposited in warm oceans and observed worldwide. His study on the cap carbonates by carbon isotope analysis revealed convincingly that biotic activities completely ceased immediately after glaciation. This result is concordant with the following snowball Earth hypothesis. The snowball Earth event was followed by rapid ice sheet melting under extremely warm conditions, due to a significant greenhouse effect of vast emission of volcanogenic CO_2 gas. CO_2-induced strong weathering of surface rocks provided abundant elements in the world seawater to form carbonates with carbon dioxide, i.e., depositing thick carbonate strata, whereas the organic activities remained dormant for some time. Hoffman further demonstrated that the snowball Earth condition occurred twice during the period of 720–640 million years ago. These drastic environmental changes on a global scale may have driven the rapid diversification of animals in the Cambrian period approximately 520 million years ago (Cambrian explosion).

Plate tectonics is a framework that describes relative motions (formation, horizontal movement, and subduction) of multiple tectonic plates, which form the rock crust that covers Earth's surface. All geological phenomena currently observed, such as earthquakes, volcanic activity, and orogeny can be explained in a unified and consistent manner in this framework. Plate tectonics are solely found on Earth, thus it is likely the most critical factor that led to the habitable surface environment of the Earth. However, until the early 1980s, tectonic plate motions could only be traced back to approximately 500 million years ago and no further. Based on the extensive and detailed field survey in Arctic Canada, Hoffman demonstrated that the core of the present North American continent formed approximately two billion years ago by the multiple collisions and mergers of several major continental blocks. Furthermore, he revealed that the supercontinent cycles of repeated assemblies and breakups of smaller continental blocks took place 4–5 times from approximately 2.5 billion years ago to the present. Thus, he demonstrated that plate tectonics dates back to the first half of the 4.6 billion years of Earth's history.

Throughout his lifetime geological research, Hoffman has shown that the essential factor for making the Earth habitable, as we know today, was the interaction between the solid Earth, atmosphere, hydrosphere, and even the biosphere. He is still actively continuing his research.

BIOGRAPHY OF THE 2024 KYOTO PRIZE LAUREATE IN ARTS AND PHILOSOPHY

Prize Field: Theater, Cinema

William Forsythe

Choreographer

Brief Biography

1949	Born in Long Island, New York, U.S.A.
1967	Began classical training at Jacksonville University
1969	Received scholarship to the Joffrey Ballet School
1973	Joined the Stuttgart Ballet
1976	Created *Urlicht,* his first professional choreographic work
	Appointed Resident Choreographer of Stuttgart Ballet
1984–2004	Director, Ballet Frankfurt
2005–2015	Director, The Forsythe Company

Selected Awards and Honors

1988, 1999, 2004, 2007	New York Dance and Performance Award (Bessie Award)
1992, 1999	Olivier Award
1997	German Federal Cross of Merit (First Class)
1999	Commandeur des Arts et des Lettres, France
2002	Wexner Prize
2010	Golden Lion for Lifetime Achievement for Dance, Venice Biennale
2020	Lifetime Achievement, German Theater Prize DER FAUST

Selected Works

1976	*Urlicht*
1983	*Gänge*
1984	*Artifact*
1985	*LDC*
1987	*In the Middle, Somewhat Elevated*
1988	*Impressing the Czar*
1990	*Limb's Theorem*
1991	*The Loss of Small Detail*
1995	*Eidos: Telos*
1999	*Improvisation Technologies. A Tool for the Analytical Dance Eye* (CD-ROM)
2000	*Kammer/Kammer*
2003	*Decreation*
2005	*Three Atmospheric Studies*
	Human Writes
2006	*Heterotopia*
2008	*I Don't Believe in Outer Space*
2013	*Nowhere and Everywhere at the Same Time No.2* (installation)
2014	*Black Flags* (installation)
2021	*The Sense of Things* (installation)

ACHIEVEMENTS OF THE 2024 KYOTO PRIZE LAUREATE IN ARTS AND PHILOSOPHY

Prize Field: Theater, Cinema

William Forsythe

The Choreographer Who Opened a New Horizon of Performing Arts by Radically Renewing Methodologies and Aesthetics of Ballet and Dance

William Forsythe radically deconstructs the style of traditional ballet to create new methodologies and aesthetics of theatrical dance. He continues to extend the potential of the art form using human bodies through various innovative works.

Forsythe, born in 1949 in Long Island, New York, studied ballet at Jacksonville University in Florida and subsequently worked with the Joffrey Ballet in New York. He then joined the Stuttgart Ballet in Germany in 1973. While performing as a dancer there, Forsythe created his first professional choreographic work, *Urlicht*, in 1976. In 1984, he became director of the Ballet Frankfurt and gained international fame by releasing a series of major choreographic works, including those commissioned by top ballet companies, such as the Paris Opera Ballet. After the Ballet Frankfurt was closed in 2004, he led The Forsythe Company from 2005 to 2015. Forsythe, now based in the United States, has been active in creating ballet, dance, and installations worldwide.

Forsythe's innovation is prominent as he continually questions and expands the structure of ballet pieces. In *Artifact* (1984), for example, the sudden falls of the stage curtain, while the dancers' moves are going on, often violently discontinue the developments of the performance. The accumulation of these fragmented scenes with no logical conclusions brings about a mesmerizing experience to the audience, as though a mighty force, such as a crashing giant wave or lightning, confronted them.

The dancers' movements, destructively exploiting the established norms, unfold beautiful but overwhelmingly tense scenes. *In the Middle, Somewhat Elevated* (1987) shows off dancers' sharp steps, most prominently hyper-extensions of their limbs, while creating the powerful impression that the tips of their toe shoes are being thrust into the floor amid the electronic sounds. Forsythe herewith asserts the aesthetics of thrill and strength, a stark contrast to the harmony and elegance that have been the hallmark of traditional ballet.

Forsythe's originality goes beyond the conventional concept of choreography, where choreographers conceive and direct movements and poses for the consistency of the narrative and styles, and dancers perform them. Forsythe pioneered a stunning methodology to expand the potential for improvisation, allowing dancers to generate movements during the performance spontaneously. To make this methodology public, Forsythe produced *Improvisation Technologies. A Tool for the Analytical Dance Eye* (1994, 1999), a digital learning material simultaneously displaying body movements, verbal descriptions, and animations to trace these movements.

Furthermore, Forsythe examines the human bodily experience and the principles of performing arts in a series of works called *Choreographic Objects*, including installations and videos. Examples include *Nowhere and Everywhere at the Same Time No. 2* (2013), a room with numerous pendulums hung from the ceiling. The audience must attentively avoid the pendulums moving irregularly to walk through the room. In this installation, the audience appears to perform a dance choreographed by the physical environment. *Black Flags* (2014) is an installation in which the two industrial robots are programmed to wave two giant flags variously. This work is a practice of choreographing nonhuman objects. *Choreographic Objects* stimulate the audience to question the relationship between their bodies and the environment.

Among Western art forms, most of which tend to be dominated by visual and auditory sensibilities, modern ballet and dance have been remarkable in highlighting immediate physicality and showing new orientations in arts and philosophy. Forsythe has been at the cutting edge of this movement for almost 50 years, and the fundamental impact of his achievements will remain uncontested far into the future.