The 26th Science in Japan Forum

Quantum Taste of the Universe

Cosmos Club
Washington, DC
June 9, 2023

Japan Society for the Promotion of Science
日本学術振興会

AAAS · U.S. Department of Energy Office of Science · KEK High Energy Accelerator Research Organization · NSF · QuS · Toyota Chuken · wpi

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AIMR
Advanced Institute for Materials Research
Tohoku University

Universe

IPMU
Kavli Institute for the Physics and Mathematics of the Universe
The University of Tokyo

Cells & Materials

iCeMS
Institute for Integrated Cell-Material Sciences
Kyoto University

Immunology

iFReC
Immunology Frontier Research Center
Osaka University

Nanotechnology

MANA
Research Center for Materials Nanoarchitectonics
National Institute for Materials Science (NIMS)

Energy

I²CNER
International Institute for Carbon-Neutral Energy Research
Kyushu University

Sleep

IIIS
International Institute for Integrative Sleep Medicine
University of Tsukuba

Earth & Life

ELSI
Earth-Life Science Institute
Tokyo Institute of Technology

Molecules

ITbM
Institute of Transformative Bio-Molecules
Nagoya University

Neurointelligence

IRCN
International Research Center for Neurointelligence
The University of Tokyo

Nano Life Science

NanoLSI
Nano Life Science Institute
Kanazawa University

Chemical Reaction Design

ICReDD
Institute for Chemical Reaction Design and Discovery
Hokkaido University

Human Biology

ASHBi
Institute for the Advanced Study of Human Biology
Kyoto University

Measurement Science

International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles
High Energy Accelerator Research Organization (KEK)

Human Metaverse Medicine

PRIME
Premium Research Institute for Human Metaverse Medicine
Osaka University

Knotted Matter

SKCM²
International Institute for Sustainability with Knotted Chiral Meta Matter
Hiroshima University

Biology & Quantum

Bio2Q
Human Biology-Microbiome-Quantum Research Center
Keio University

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MEXT MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY-JAPAN

JSPS JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE 日本学術振興会

The Twenty-Sixth
"Science in Japan" Forum

Quantum Taste of the Universe

Cosmos Club
Washington, DC
June 9, 2023

Sponsored by
Japan Society for the Promotion of Science

Co-sponsored by
AAAS (American Association for the Advancement of Science)
DOE (Department of Energy)
KEK (High Energy Accelerator Research Organization)
NSF (National Science Foundation)
QUP (International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles)
Toyota Central R&D Labs., Inc.
US and Canada JSPS Alumni Association
WPI (World Premier International Research Center Initiative)

Agenda (Updated)

12:00 pm - Registration

1:00 pm - 1:20 pm

Opening Remarks

Junji Urakawa, Director, Japan Society for the Promotion of Science Washington Office

Koichi Ai, Minister, Embassy of Japan in the United States of America

Kimberly J. Montgomery, Director of International Affairs and Science Diplomacy, Center for Science Diplomacy, American Association for the Advancement of Science

Anne L. Emig, Cluster Lead for Programs and Analysis, Program Director for Japan, National Science Foundation

1:20 pm - 2:00 pm

Keynote Speech: Tasting the quantum universe with the quantum devices

Masashi Hazumi, QUP Director / Professor, KEK

2:00 pm – 3:00 pm

Session 1: Observations of the quantum fields in the early universe through Cosmic Microwave Background (CMB)

"Ultra-high Energy Physics with the Cosmic Microwave Background"

Adrian T. Lee, QUP Principal Investigator / Professor, University of California, Berkeley

"Exploring the Early Universe and the Evolution of the Universe: A View from the Ground"

Akito Kusaka, Associate Professor, Department of Physics, The University of Tokyo / Senior Scientist, Physics Division, Lawrence Berkeley National Laboratory

3:00 pm – 3:20 pm Coffee Break

3:20 pm – 4:20 pm

Session 2: Dark Matter, searching for relic quantum fields in the current universe

"Dark Matter, Axions, and Quantum Sensors"

Reina Maruyama, Professor, Department of Physics, Yale University

"Light Dark Matter searches with innovative quantum sensors"

Maurice Garcia-Sciveres, QUP Principal Investigator /Senior scientist, Physics Division, Lawrence Berkeley National Laboratory

4:20 pm – 4:50 pm

Session 3: Quantum field and future society

"Manipulating classical and quantum waves"

Hideo Iizuka, QUP Principal Investigator / Senior Fellow, Toyota Central R&D Labs., Inc.

4:50 pm – 5:10 pm Coffee Break

5:10 pm – 6:00 pm

Session 4: Panel Discussion "Future of quantum-field measurements"

Moderator:

Dmitri Denisov, Deputy Associate Laboratory Director for High Energy Physics, Brookhaven National Laboratory / Professor Department of Physics and Astronomy, Stony Brook University

+ All Speakers

6:00 pm –

Closing Remarks

Keisuke Okamura, First Secretary, Embassy of Japan in the United States of America

6:10 pm –

Reception

<For All Participants>

- JSPS will take some photographs and video recordings during the forum. They may be used for the website and other publications by host organizations.
- Please do not take pictures or videos.

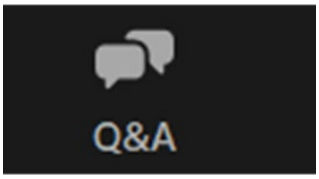
<Request for In-person Participants>

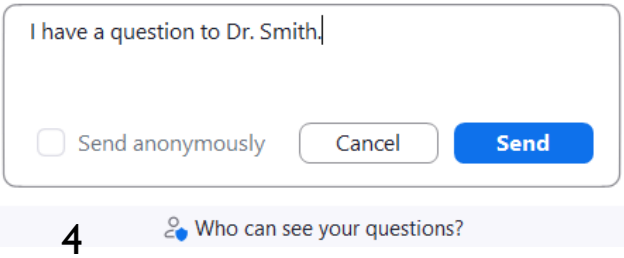
- There will be no Q&A after each talk. If you have questions, please come to the mic stand during the panel discussion session.

<Request For Zoom Participants>

- Be sure to mute your microphone and turn off your camera.

- There will be no Q&A after each talk.
  Questions from the online audience can be asked via Zoom Q&A function during the panel discussion session.





Foreword

The “Science-in-Japan” Forum was started in 1996 to be held annually in Washington D.C. by Dr. Masatoshi Koshiba as the Director of the Japan Society for the Promotion of Science (JSPS) Washington Office (WO) to promote the scientific cooperation between Japan and the United States.

The 26th Forum for 2023 is on “Quantum Taste of the Universe” which will be obtained by developing the International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles (QUP) that can explore the quantum universe. The QUP was newly established in 2021 at KEK.

When I recognized this title in March, I remembered the interesting book which title is “What is Real?” written by Adam Becker. The subtitle of this book is “The Unfinished Quest for the Meaning of Quantum Physics”. So, I read it again before this Forum. I strongly recommend this book to all participants today. Also, I am expecting good collaboration and competition between the United States and Japan through this Forum stimulation soon.

This Forum is co-sponsored by AAAS (American Association for the Advancement of Science), DOE (Department of Energy), KEK (High Energy Accelerator Research Organization), NSF (National Science Foundation), QUP, Toyota Central R&D Labs., Inc., US and Canada JSPS AA (Alumni Association), and WPI (World Premier International Research Center Initiative). I just followed the work for this Forum preparation by Dr. Hirata who was former Director of JSPS WO. Also, the staff of JSPS WO and the QUP efficiently prepared this Forum. I would like to express my gratitude to all of them.

I hope all the participants will find the Forum useful and enjoyable.

浦川順治

Junji Urakawa
Director, JSPS Washington Office

Keynote Speech

Masashi Hazumi

Director, Principal Investigator and Professor,
International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles (QUP)
High-energy Accelerator Research Organization (KEK)

Abstract

How did the Universe begin? What physical laws governed it? These questions arouse our keen curiosity and sense of wonder. Humankind has been pursuing these questions for a long time. Significant observations and discoveries about the Universe have occurred between the second half of the 20th century and the present, leading to the astonishing Big Bang picture of the Universe. Discoveries in particle physics also occurred hand-in-hand. To go beyond, we now need to address five outstanding cosmological issues that we cannot explain in the standard model of particle physics. Keywords are cosmic inflation, matter-antimatter asymmetry, neutrino properties, dark matter, and dark energy. All of them are gateways to explore the quantum nature of the Universe. There are two approaches to address these issues. One is a theoretical approach, such as those by Albert Einstein, Richard Feynman, Hideki Yukawa, etc. The other is an experimental/observational approach where new measurement systems make a breakthrough. This forum focuses on the latter and describes our "new eyes" to look into the Universe and particle physics beyond the standard model. Also, inventions in basic science, such as particle physics and cosmology, are arguably one of the most efficient ways for disruptive innovations that change society. We are indeed entering a new era where interactions between basic science and industrial research are so strong that the two areas of research look almost unified. The International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles (QUP), newly established in December 2021 at KEK, an internationally leading accelerator research institute, is an excellent example of this trend. Marcel Proust said, "The only real voyage of discovery consists not in seeking new landscapes, but in having new eyes." Welcome to the world of quantum-field measurement systems for studies of the Universe and particles!

As a physicist, I pursue the fundamental laws of elementary particles and space-time, developing ideas for experiments and observations, setting up and executing projects, and writing scientific papers. My current passion is the experimental verification of the cosmic inflation theory. To this end, I am collaborating internationally to observe the polarization of the cosmic microwave background radiation. I proposed the LiteBIRD satellite mission, which JAXA selected as a strategic L-class mission with a launch around 2030, and serve as the global PI of the LiteBIRD collaboration. At QUP, I work as the director and a PI.
Before jumping into experimental cosmology, I worked on particle physics experiments, including the Belle experiment at the KEK B factory.

Present

Director, Principal Investigator and Professor,
International Center for Quantum-field Measurement Systems for Studies of the Universe and Particles (QUP),
High-energy Accelerator Research Organization (KEK)

Education

1983 - 1988 The University of Tokyo, Tokyo, Japan
1988 - 1993 Graduate school of science, the University of Tokyo

Academic Career

1993 - 1994 Post-Doctoral Fellow, The University of Tokyo
(Professor Sakue Yamada's laboratory)
1994 - 2001 Assistant Professor, Osaka University, Osaka, Japan
(Professor Yorikiyo Nagashima's laboratory)
2001 - 2007 Associate Professor, Institute of Particle and Nuclear Studies (IPNS), KEK
2007 - 2021 Professor, IPNS, KEK
2021 - Present Director, Principal Investigator and Professor, QUP

Academic awards

2007 The 4th Japan Society for the Promotion of Science Prize (JSPS Prize)
for "Discovery of CP Violation in B Mesons"

Ultra-high Energy Physics with the Cosmic Microwave Background

Adrian T. Lee

Professor, Department of Physics, University of California Berkeley
Principal Investigator, QUP Satellite at U.C. Berkeley
Faculty Scientist, Physics Division, Lawrence Berkeley National Laboratory
PhD in Physics

Abstract

Observations of the cosmic microwave background (CMB) have revolutionized our view of the universe. The discovery of the CMB in 1965 gave strong evidence that the universe started in a hot Big Bang. From the COBE satellite, we learned that the seeds of all the structure in the universe were present shortly after the Big Bang. This picture of the universe was refined with the WMAP and Planck satellites. We are working on a 4th CMB satellite, led by JAXA, called LiteBIRD which is designed to search for a signature of a period of "inflation" where all of space expanded exponentially for a fraction of second at the time of the Big Bang. The inflation hypothesis, if correct, would explain why the entire visible universe is at one temperature and why the geometry of the universe is flat rather than curved.

I will describe the inflation model, the design of the LiteBIRD space mission, and the deep collaboration between Japan and the U.S. on LiteBIRD. I will discuss the detector system which is the heart of the experiment.

I am naturally drawn to fundamental Physics such as the question of what happened in the first instant of universe and what are Dark Matter and Dark Energy? I am working on a series of CMB experiments including Simons Array (collecting data) Simons Observatory (deploying now), and LiteBIRD and CMB-S4 which are slated to start data at the end of the decade. I have helped pioneer the transition-edge sensor (TES) bolometer detectors used by all these experiments.

Present
(Professor, Department of University of California, Berkeley; Faculty Scientist, Lawrence Berkeley National Lab; Principal Investigator, QUP Satellite at U.C. Berkeley)

Education
1982 - 1986 Undergraduate Student in the Faculty of Physics
Columbia University, Obtained B.A.
1986 - 1994 Graduate Student in the Department of Physics Stanford University, Obtained Ph.D.
(Thesis advisor; Dr. Blas Cabrera

Academic Career
1993 - 1994 Post-Doctoral Fellow at the Stanford Medical School,
Stanford University (Dr. Gary Glover's laboratory)
1994 - 2000 Post-Doctoral Fellow at the Physics Department,
University of California, Berkeley (Professor Paul Richards' laboratory)

2000 - 2004 Assistant Professor at the Physics Department,
University of California, Berkeley
2004 - 2009 Associate Professor at the Physics Department,
University of California, Berkeley
2009 - Present Professor at the Physics Department,
University of California, Berkeley

Exploring the Early Universe and the Evolution of the Universe: A View from the Ground

Akito Kusaka

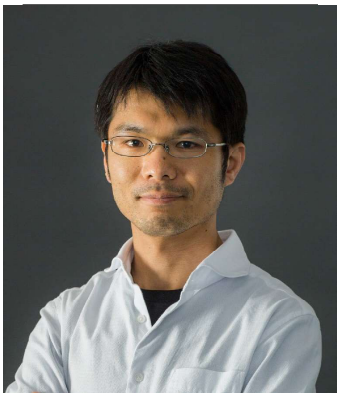
Associate Professor, Department of Physics, the University of Tokyo / Senior Scientist, Physics Division, Lawrence Berkeley National Laboratory
PhD in Physics

Abstract

The Big Bang is believed to have occurred at the beginning of the universe, but what caused it, and how did the universe evolve after the Big Bang? The cosmic microwave background (CMB) provides valuable insights into these fundamental questions. As a remnant of the Big Bang, CMB offers a unique window into the early universe and its evolution. In this talk, we will discuss how ground-based telescopes observe the CMB and what scientists can learn from these observations: beginning of the Universe and the dark content of the universe. Then, we will dive into some of the latest CMB projects and review cutting-edge technologies they use, such as superconducting detectors and cryogenic instruments. We will also touch on the fruitful collaboration between US and Japanese scientists in the CMB observation and the development of these technologies. Finally, we will briefly mention our recent advancements in applying quantum sensing technologies to the search for ultralight dark matter, inspired by the technology development for CMB telescopes.

I have a passion for observational cosmology, with a specific interest in measuring the polarization of the cosmic microwave background (CMB). However, my interests extend to a broad range of physics, including the origins of the universe, dark matter and energy, neutrino properties, the nature of gravity, and possible connections between gravity and quantum mechanics.

To pursue these interests, I have been involved in several ground-based projects for CMB observation, including QUIET, ABS, Simons Array, Simons Observatory, and CMB-S4. I firmly believe that new technologies provide us with the ability to see new aspects of nature, which is why I am always attracted to emerging and rapidly-evolving technologies. In particular, I am excited about the application of quantum sensing technologies to cosmology and particle physics, and the potential insights that these technologies may offer in the future.



Present

Associate Professor, Department of Physics, the University of Tokyo
Senior Scientist, Physics Division, Lawrence Berkeley National Laboratory

Education

1998 - 2002 B.S., Physics, The University of Tokyo, Japan
2002 - 2004 M.S., Physics, The University of Tokyo, Japan
2004 - 2007 Ph.D., Physics, The University of Tokyo, Japan (Thesis advisor; Dr. Hiroaki Aihara)

Academic Career

2007 - 2011 Postdoctoral Fellow at the Kavli Institute for Cosmological Physics (KICP), University of Chicago
2011 - 2014 Postdoctoral Fellow at the Department of Physics, Princeton University
2014 - 2017 Divisional Fellow, Physics Division, Lawrence Berkeley National Laboratory
2017 - Present Senior Scientist, Physics Division, Lawrence Berkeley National Laboratory
2017 - Present Associate Professor, Department of Physics, The University of Tokyo

Dark Matter, Axions, and Quantum Sensors

Reina Maruyama

Professor, Department of Physics, Yale University
PhD in Physics

Abstract

We now have overwhelming evidence for the existence of dark matter from our astrophysical observations. Theorists have proposed several particles as dark matter candidates, including axions and weakly interacting massive particles (WIMPs). If they are the correct dark matter candidate, axions will convert into photons in the presence of a magnetic field. There is a global effort to elucidate the identity of dark matter, and as we do so, we are pushing the boundaries of technological capabilities available to us. Quantum sensors give us access to never-before-explored forms of dark matter, leveraging quantum phenomena to make measurements by manipulating quantum states, entanglement, and superposition. At Yale, for example, we are searching for axions in the $10 - 50$ μeV mass range with the HAYSTAC experiment and developing new techniques for detecting and transporting photons. Many in the particle physics community are exploring the potential for how the applications of quantum technologies will advance our understanding of fundamental physics questions such as measurements of the cosmic microwave background, dark matter direct detection, dark energy, axions, permanent electric dipole moments, and other symmetry violation searches. In this talk, I will discuss the status of dark matter searches and the role of quantum sensors in this field.

Dr. Reina Maruyama is a Professor of Physics and Astronomy at Yale University. Dr. Maruyama is an experimental nuclear, particle, and atomic physicist who studies the identities and characteristics of neutrinos and dark matter. Dr. Maruyama is a co-spokesperson of the COSINE-100 experiment to elucidate the validity of the claim for the discovery of dark matter by the DAMA collaboration. She is also searching for neutrinoless double beta decay with CUORE, the upcoming CUPID experiments, and axions with the HAYSTAC experiment.

Present

Professor, Department of Physics, Yale University

Education

1991 - 1995 B.S., Applied Physics, Columbia University, New York, NY
1995 - 2003 Ph.D., Department of Physics, University of Washington, Seattle, WA
(Thesis advisor; Dr. E. Norval Fortson)

Academic Career

2003 - 2006 Chancellor's Postdoctoral Fellow, Postdoctoral Research Associate,
University of California, Berkeley & Lawrence Berkeley NationalLaboratory
(Dr. Stuart Freedman's laboratory
2006 - 2010 Assistant Scientist, IceCube Research Center, Univ. of Wisconsin-Madison
2011 - 2013 Assistant Professor of Physics, University of Wisconsin-Madison
2013 - 2016 Assistant Professor of Physics, Yale University
2016 - 2021 Associate Professor of Physics with tenure, Yale University
2021 - Present Professor of Physics, Yale University

Academic awards

2003 Chancellor's Postdoctoral Fellowship, University of California, Berkeley
2012 NSF CAREER Award
2016 Sloan Research Fellowship
2020 American Physical Society (APS) Fellow
2021 Connecticut Academy of Science and Engineering (CASE)

Light Dark Matter searches with innovative quantum sensors

Maurice Garcia-Sciveres

Senior scientist, Physics Division, Lawrence Berkeley National Lab
PhD in Physics

Abstract

Elucidating the nature of dark matter is one of the 21st century's paramount challenges in physics. We already know a lot about dark matter, but all this knowledge comes form observations on galactic or larger scales. These tell us that here on Earth dark matter is a gas, like the air, with known density and wind speed. But we do not know what this gas is made of. Theoretical models suggest dark matter may be made of particles, just as air is made of molecules, and so the race is on among physicists to be the first to detect those dark matter particles in the lab. This is difficult, because, even in a vessel evacuated with the best pump one can buy, there would still be more residual air than dark matter. Furthermore, dark matter hardly interacts with matter at all (similar to neutrinos) or else things would look totally different on galactic and larger scales. So it cannot be concentrated, contained, or manipulated in any way using equipment made of matter. The dark matter gas, though incredibly low density, is everywhere: inside us, the Earth, and everything else as if nothing existed. Therefore, we search for dark matter particles by looking for very feeble energy signals in selected materials at temperatures near absolute zero, deep underground, and with ultra low activity equipment, where things are as quiet as we can possible make them. Our quest takes us far into the noise of everyday materials and equipment, to see what is hiding there. This work is done by a collaboration of US and Japanese scientists supported by a US-Japan funding award, KEK's QUP, and the Tohoku University Research Center for Neutrino Science at the Kamioka mine, near Toyama. The endeavor benefits form quantum measurement techniques and quantum information science technology. Quantum computers are in fact very sensitive to the same everyday noise, which means that both dark matter and quantum computing research can join forces to strive to eliminate it, so that one day we can see what is hiding underneath it, and perform error-free quantum computations.

My research focus is on instrumentation development for discovery of new particle interactions at both extremes of energy and intensity. At the high energy/intensity extreme I focus on hybrid pixel detector technology and pixel readout integrated circuits in particular. I have been a member of the ATLAS experiment since 2000 and had a major role in the development of its pixel detector. I now co-lead the cern.ch/RD53 collaboration after co-founding it in 2013, which is delivering the pixel readout integrated circuits (the most complex chips developed for particle physics to date) for the coming upgrades of both the ATLAS and CMS experiments at the Large Hadron Collider.
At the low energy/intensity extreme I focus on technology to extend sensitivity of low mass particle dark matter searches, for example in the SPICE-HeRALD experiment of which I am a member. I have led the Berkeley/Caltech/Princeton/U.Mass/Yale QuantISED Quest program since 2018, which aims to develop new types of low energy noiseless phonon sensors leveraging QIS advances. More recently as a co-PI of QUP I co-lead the development of a new Cryolab at the Kamioka mine, which will be featured in this talk.

Present

Senior Scientist, Lawrence Berkeley National Lab., Berkeley CA

Education

1985 - 1988 Undergraduate BA, Hamilton College, Clinton, NY

1988 - 1994 Graduate PhD in Physics, Cornell University, Ithaca,NY
(Thesis advisor; Prof. Persis S. Drell)

Academic Career

1994 - 2000 Post-Doctoral Fellow at Lawrence Berkeley National Lab.
CDF Experiment group, Physics Division

2000 - 2010 Staff Scientist at Lawrence Berkeley National Lab.
ATLAS experiment group, Physics Division

2010 - Present Senior Scientist at Lawrence Berkeley National Lab.
Physics Division

Academic awards

2015 Fellow, American Physical Society

Manipulating classical and quantum waves

Hideo Iizuka

Principal Investigator, QUP
Senior Fellow, Toyota Central R&D Labs., Inc.
Dr of Engineering

Abstract

Suppose the particle physics and the automotive industry. At first glance, those are far different areas of science and engineering. QUP provides opportunities where researchers in such different areas can interact. We now believe that there are common technologies, which can enhance the technological strength in each area, and come up with intriguing ideas through the synergy effect.
Our team has been investigating Casimir forces toward two research directions; one is to search for new forces. The other is to lead to possible applications, e.g., a non-contact shaft-bearing system. In addition, the team has started the investigation on nitrogen-vacancy centers in diamonds for light dark matter search. I will present recent theoretical works on Casimir forces and nitrogen-vacancy centers in diamonds. Currently the experimental setup for each is going on. In addition, I will introduce a few research examples of automotive applications, where the analogy of physics has been incorporated.

Over 25 years' experience in R&D in the automotive industry. For the first 10 years he was involved in projects on the developments of millimeter-wave radar systems, digital TV reception systems, and tire-pressure monitoring systems. Since then, he has been conducting fundamental research in optics and heat management at the nanoscale, as well as applied research in sound waves and vibration waves. His recent research activity includes a challenge on manipulating Casimir forces arising from quantum and thermal fluctuations. He wants to be able to manipulate "waves".

Present

Principal Investigator at QUP
Senior Fellow at Toyota Central R&D Labs., Inc.

Education

1991 - 1995 Undergraduate Student in the Faculty of Engineering, Saitama University, Obtained B.S.
1995 - 1997 Graduate Student in the Graduate School of Engineering, Saitama University, Obtained M.S.
2005 - 2007 Graduate Student in the Graduate School of Engineering, Nagoya Institute of Technology, Obtained Dr. Eng. (Thesis advisor; Prof. Nobuyoshi Kikuma)

Career

1997 - 2001 Researcher at Toyota Central R&D Labs., Inc. (TCRDL), Japan
2001 - 2002 Visiting scholar at the University of Birmingham, UK (Prof. Peter S Hall' laboratory)
2002 - 2008 Researcher at TCRDL, Japan
2008 - 2011 Researcher at Toyota Research Institute of North America (TRINA), Toyota Motor Engineering & Manufacturing North America, Inc., USA
2011 - 2017 Research Leader at TCRDL, Japan
2017 - 2021 Research Leader at TRINA, Toyota Motor North America, Inc., USA
2021 - Present Senior Fellow at TCRDL, Japan
Principal Investigator at QUP

Moderator

Dmitri Denisov

Deputy Associate Laboratory Director for High Energy Physics, Brookhaven National Laboratory
Professor Department of Physics and Astronomy, Stony Brook University

Present

Deputy Associate Laboratory Director for High Energy Physics
Brookhaven National Laboratory
Professor Department of Physics and Astronomy, Stony Brook University

Education

1978 - 1984 Undergraduate Student at Moscow Physical Technical Institute, B.Sc. in Physics
1984 - 1991 Graduate Student at the Institute for High Energy Physics, Protvino, PhD Title "Study of cumulative protons production in hadron-nuclei collisions at 40 GeV/c". Advisor: Dr. Yu. M. Antipov

Academic Career

1989 - 1993 Institute for High Energy Physics, Protvino: Staff Scientist
1990 - 1991 Moscow Physical Technical Institute, Moscow: Lecturer.
1993 - 1994 Superconducting Super Collider Laboratory, Texas: Associate Scientist
1994 - 1999 Fermi National Accelerator Laboratory, Illinois: Associate Scientist
1999 - 2005 Fermi National Accelerator Laboratory, Illinois: Scientist
2005 - 2011 Fermi National Accelerator Laboratory, Illinois: Senior Scientist
2011 - 2019 Fermi National Accelerator Laboratory, Illinois: Distinguished Scientist

Academic awards

2008 Czech Technical University Medal for achievements in high energy physics and development of international cooperation
2010 Fellow of the American Physical Society
2016 Physical Review B journal referee award
2017 "Best Article of 2015" award from Physics Uspehi journal for the review paper "The top quark (20 years after its discovery)"
2019 Recipient of 2019 European Physical Society award for the discovery and studies of the top quark by the D0 and CDF collaborations

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JAPAN SOCIETY FOR THE PROMOTION OF SCIENCE
日本学術振興会

Founded in 1932 with an endowment of Emperor Showa,
the Japan Society for the Promotion of Science (JSPS) is Japan's core independent funding agency.
JSPS supports from basic to applied research conducted based on
curiosity-driven research and the free ideas of researchers.
JSPS covers the entire spectrum of academic fields
including the humanities, social sciences, and natural sciences.

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