April 2012–March 2013

Kavli IPMU

ANNUAL REPORT 2012

World Premier International Research Center Initiative

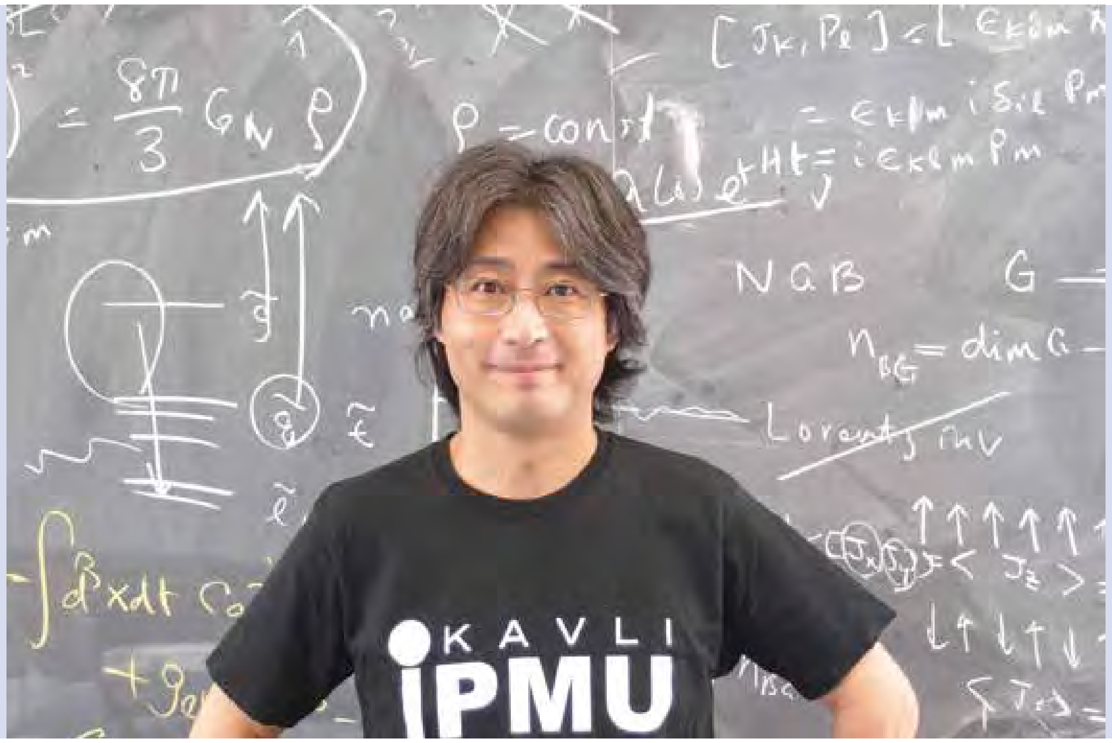
THE UNIVERSITY OF TOKYO

TODIAS
東京大学国際高等研究所
TODAI INSTITUTES FOR ADVANCED STUDY

KAVLI IPMU INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE

Kavli IPMU Annual Report 2012 April 2012–March 2013

1 Mission



Director Hitoshi Murayama

It is hard to believe now that this institute did not exist five and a half years ago. The building is buzzing with discussions, seminars, workshops, video meetings with US, Europe, or other parts of Asia, and about a thousand visitors a year. And most importantly, the research at Kavli IPMU is producing results. Yet we need to work further to become a permanent and mature institute.

The quest to solve the mysteries of the Universe is common for any culture, language, or ethnicity. Kavli IPMU embodies this common quest. We have a very interesting spectrum of people. Experimentalists and observers talk to the Universe directly, obtaining valuable data using instruments based on cutting-edge technology. Theorists act as interpreters trying to decipher messages from the Universe. This part of interplay is well-known. Yet we often lack the vocabulary to interpret such precious messages simply because human language is based on our daily experience, not near the horizon of a black hole or when the whole visible Universe was smaller than the size of an atom.

Mathematicians develop new vocabularies and grammars in a logically consistent fashion. Eugene Wigner, a Nobel laureate in physics, once remarked about “the unreasonable effectiveness of mathematics in natural sciences.” Surely we benefit greatly from our mathematicians on site to formulate messages from the Universe into concrete theories. Then the process goes the other way. Precise mathematical formulation of the problem allows theorists to make falsifiable predictions, which experimentalists and observers take up as their next challenge to prove or disprove.

This coexistence of experimentalists, observers, theorists and mathematicians is unique among research institutions on the planet. We believe we are poised to make breakthroughs using this combination of talents. The world took notice. We are the best known institute among the five centers launched by the WPI (World Premier International Research Center Initiative) program back in 2007. Our research program is attracting the best talents as ever. Several of our new members have turned down some of most prestigious positions elsewhere. Our ongoing and future projects fascinate scientists around the globe.

Building an international institute from scratch was not easy. But thanks to the effort by our colleagues, staff, the University, and MEXT, we got off the ground very quickly and incredibly well. Stay tuned what we will discover in the next few years.

Our Mission

Our mission is very simple. Just like when you looked up the night sky when you were young, human beings are naturally drawn to basic and profound questions. *Where do we come from? Where are we going? How did the Universe begin? Does it have an end? How does it work?* The first step to answer these questions is to understand *what the Universe is made of*.

At the Frontier

We are making tremendous progress. David Spergel (PI) and Eiichiro Komatsu (Affiliate Senior Researcher) discovered that 96% of the Universe is unknown. Dark Matter, that makes up about a quarter of the Universe, is responsible for creating stars and galaxies in the Universe, that allowed the solar system and us to be born. On the other hand, Dark Energy, about 70% of the Universe, is ripping our Universe apart. The history of the Universe has been based on the battle of these two titans. They are the genomes of the Universe; many of our members are working together, just about to start a *cosmic genome project*, using the Subaru telescope and many other experiments.

We would not exist unless matter and anti-matter could be reshuffled at the level of one part in a billion. We need to find how matter and anti-matter can transform to each other. KamLAND-ZEN project, initiated by our Assistant Professor Alexandre Kozlov, currently has the world best limit on it. At the same time, we need a new theory that combines science of the large (general relativity) and of the small (quantum mechanics), so that we can study what exactly the Big Bang was. Our Professor Kentaro Hori has the most rigorous mathematical formulation to build such a theory.

This way, we are pushing the frontier of our knowledge in all possible directions.

Interdisciplinary Research

Interaction among researchers from different disciplines is at the heart of Kavli IPMU. At daily tea time at 3pm, scientists fire naïve and basic questions they were hesitant to ask during formal seminars. They throw problems at each other asking for help. Many stay on till late in the afternoon discussing new ideas they came up with during the tea time. The casual atmosphere promotes this kind of interactions.

Some of such interactions lead to research papers. We have seen mathematicians and physicists writing papers together, a very rare phenomenon. Astronomers and physicists work together for the next big project. People even ventured to work with other areas such as condensed matter physics.

Systemic Reform and Globalization

Despite a high level of scientific research in Japan, there has been a sense that it was somewhat disconnected from the rest of the world. We have created a constant flow of scientists to and from Japan. It has helped boost our visibility.

At the same time, our science is completely global and also our membership. More than a half of our scientific staff originated from other countries. This was made possible by reforming the traditional systems at the University of Tokyo. We provide meticulous support for our scientists. For non-Japanese members, we even support various aspects of life in Japan. We can offer competitive merit-based salaries. Split appointments with other institutions are now possible, yours truly being the first example.

The Kavli Foundation, a US foundation established by Mr. Fred Kavli, liked our cutting-edge science and global nature. They generously created endowment of seven and a half million dollars. This is our first annual report from the *Kavli* Institute for the Physics and Mathematics of the Universe. This is the first time such a named institute was created at Japanese National Universities.

Public Outreach

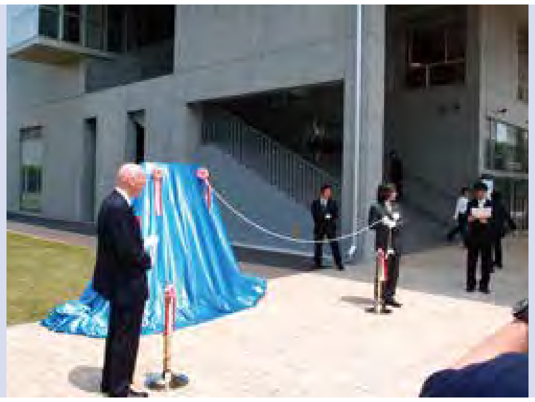
Science & Technology Festa 2013

Because our institute is supported by taxpayers' money, we make special effort to bring back the excitement of science to the sponsors. We organize many public lectures and science cafés, produce quarterly publications aimed at a general audience, some of us wrote popular science books. Fortunately, Japanese media became very interested in what we do. Combined effort appears to raise awareness of science among the general population, in particular among high-school and even younger students. As the success of the globalized world and technologically-advanced society hinges on educated and scientifically-minded workforce, we believe our effort is helping the society in the long run.

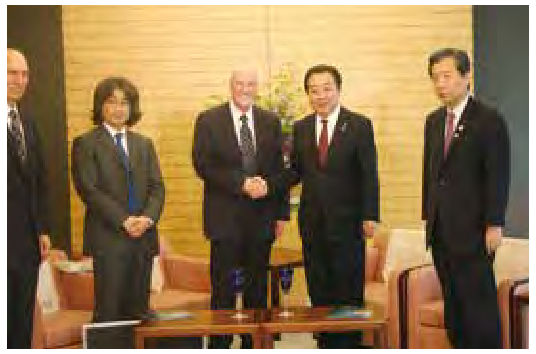
2 Introduction

Starting with JFY 2012 the IPMU was renamed as the Kavli Institute for the Physics and Mathematics of the Universe (the Kavli IPMU) following a generous endowment from the Kavli Foundation. In commemoration of this, the Kavli IPMU naming ceremony took place on May 10, 2012, at the Kavli IPMU building, with Mr. Fred Kavli, Founder and Chairman of the Kavli Foundation, in attendance. IPMU Director Hitoshi Murayama and President of the University of Tokyo Junichi Hamada were the first speakers to open the ceremony. President Hamada expressed gratitude to Mr. Kavli and offered his strong support for establishing the Kavli IPMU as a permanent entity of the University. Following the president's speech, Mr. Fred Kavli welcomed the IPMU as a member of the Kavli family and spoke about his philanthropic effort to support science. Then, congratulatory greetings were given by distinguished guests, Dr. Robert Conn, President of The Kavli Foundation, Dr. Hiroo Imura, Chairman of the WPI program, Mr. Daisuke Yoshida, Director-General of Research Promotion Bureau, MEXT, Roger Blandford from the Kavli Institute for Particle Astrophysics and Cosmology at Stanford University, George Efstathiou from the Kavli Institute for Cosmology at Cambridge University, Xiaowei Liu from the Kavli Institute for Astronomy and Astrophysics at Peking University, and, Yue-Liang Wu from the Kavli Institute for Theoretical Physics China at the Chinese Academy of Science. Also, a warm and encouraging message from Dr. Jonathan Dorfan, President of the Okinawa Institute of Science and Technology Graduate University, who unfortunately could not attend the ceremony, was presented.

At the end of the ceremony, Director Murayama and Mr. Kavli worked together to unveil the new Kavli IPMU sign in front of the Kavli IPMU building. On the front and rear surfaces of this sign are inscribed the patterns representing sketches by Galileo Galilei of Orion Nebula and Praesepe, respectively, depicted in his book, *Sidereus Nuncius*, published in 1610. These patterns shine in the night as seen in the picture.



The day before the Kavli IPMU Naming Ceremony, May 9, Director Murayama and Mr. Kavli, made a courtesy call on Prime Minister Yoshihiko Noda, accompanied by Dr. Robert Conn, Professor Sadanori Okamura, President of the Astronomical Society of Japan, and Dr. Naotaka Suzuki, Staff Scientist at the Lawrence Berkeley National Laboratory. Together with the Prime Minister, Minister Hirofumi Hirano of the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) attended from the government.



Later, the University of Tokyo presented the 2012 “Shokumon Award” to Mr. Fred Kavli. The Shokumon Award was instituted in 2002 to recognize and thank individuals, corporations, or organizations that made major contributions to the growth of the University programs through private donations, volunteer work and support, establishment of endowed chairs, or research centers. “Shokumon” is the name of the castle gate in the capital of the ancient Chinese state Qi during the civil war era (403-221 B.C.). Under King Wei (356-320 B.C.) and King Xuan (319-300 B.C.), the state treated academics very well, which brought the best minds to the capital Linzi of Qi and led to a flourishing of academic activities. The award is named after this history. The prize was awarded to Mr. Kavli in recognition of the fact that annual returns in perpetuity from the endowment established by the donation from The Kavli Foundation will help sustain the Kavli IPMU as a permanent research institute within the University of Tokyo, and also that this is a major contribution to the University of Tokyo in striving toward a new vision of the national university. Mr. Kavli is the first international recipient of this award. The award ceremony was held on October 2 at Ito Hall on the University’s Hongo campus. From The Kavli Foundation, President Robert Conn attended the ceremony on behalf of Mr. Fred Kavli.

On October 19, researchers and staff of the Kavli IPMU gathered and celebrated the 5th anniversary at the institute’s Research Building. During these five years since it was launched from scratch on the University of Tokyo’s Kashiwa campus on October 1, 2007, the IPMU has been attracting topnotch researchers from all over the world, producing a number of excellent scientific achievements, and increasing its international visibility. As a result, the IPMU was given the highest grade of “S” (superior) in the WPI Interim Review, which was carried out in 2011. Together with the completion of the IPMU Research Building in December 2009, admission to membership in the newly established TODIAS (Todai Institutes for Advanced Study) in January 2011, and becoming the Kavli IPMU by obtaining an endowment from the Kavli Foundation, the IPMU has achieved a great step forward.

A noteworthy progress in the Kavli IPMU’s research program in observational astronomy is the first light of the Hyper Suprime-Cam (HSC), the new-generation prime-focus camera of the Subaru telescope that is designed to have a 1.5-degree field-of-view in diameter, substantially wider than the current camera (Suprime-Cam) by a factor of 7, but to maintain excellent image quality. HSC is a “huge” digital camera, standing 3 meters high, weighing 3 tons, and having 116 CCD chips mounted at the focal plane, 870 million pixels in total. It has been developed by the joint efforts of National Astronomical Observatory of Japan (NAOJ), the Kavli IPMU, and other partners. At the Kavli IPMU, HSC has been developed as one of the two subprojects of the SuMIRe Project, which is supported by FIRST (The Funding Program for World-Leading Innovative R&D on Science and Technology), and led by Kavli IPMU Director Hitoshi Murayama as a core researcher. The installation of the HSC onto the NAOJ’s 8.2m Subaru Telescope in Hawaii took place on August 16-17, 2012, and its engineering first light was successfully achieved starting from the night of August 28. It was confirmed that the HSC camera properly captured lights from the star Vega. It was the exciting moment that the HSC project finally became a reality. Thanks to its large mirror aperture, wide field-of-view, and excellent image quality, the HSC becomes the most powerful survey imaging camera in the world. The HSC survey is planned to start from the middle of 2013, for 5 years duration.

Entire view of the HSC. Credit: NAOJ HSC Project.

Another important milestone of the Kavli IPMU’s efforts to address fundamental questions of the universe is participation in the Belle II experiment in November, 2012. This is important for the Kavli IPMU because full-time researcher in the field of accelerator-based high energy physics had been missing since its establishment, though the mission of the institute has to be pursued through assault on three fronts, namely underground, sky, and accelerator, tied with theoretical physics and mathematics. The Belle II experiment aims at investigating supersymmetry and other new physics possibilities at SuperKEKB, a high-luminosity electron-positron collider at the High Energy Accelerator Research Organization (KEK) in Tsukuba, Japan. The experiment is being prepared by an international collaboration with approximately 400 researchers from 15 countries, and will start in 2014. The Kavli IPMU team will participate in both detector construction and physics analysis. Important responsibilities of the Kavli IPMU in Belle II includes establishment of a super-precise assembly procedure of a silicon vertex detector, which determines decay vertices of B mesons in the precision of less than 100 micrometers.

At the end of JFY 2012, the Kavli IPMU has a total of 236 core researchers including principal investigators, faculty members, postdoctoral fellows, affiliate members, long-term visitors, and graduate students. Their research activities are supported by 38 administrative and research support staff. Besides the core researchers, many short-term visitors visit the Kavli IPMU. The number of scientific papers published in refereed journals in JFY 2012 amounted to 352.

Number of Core Researchers (March 2013)

	Number	Foreign
Principal Investigators	18	4
Professors (not including 4 PIs)	9	1
Associate Professors	9	2
Assistant Professors	9	5
Postdoctoral Fellows	43	35
Affiliate Members	106	34
Long-term Visitors	31	24
Students	11	0
Total	236	105

Research Activities in JFY 2012

Conferences	11
Seminars	232
Visitors (foreign) (cumulative number)	602 (404) 831 (495)
Preprints	253
Publications	352

News&Events (April 2012–March 2013)

April
- Press release "Instability in magnetic materials with dynamical axion field – A research method in particle physics contributes to condensed matter physics – (Physical Review Letters Editor's Suggestion)"
- Nobu Katayama joined as Associate Director
- Press release "Cosmic Mirages confirm accelerated cosmic expansion"

May
- Hitoshi Murayama and Mr. Fred Kavli made a courtesy call on Prime Minister
- Naming ceremony for the Kavli IPMU
- Press release "Subaru Telescope for the first optical observation using the adaptive optics system"
- Kavli IPMU Scientific Symposium

June
- Workshop "Science Opportunities with Wide-Field Imaging and Spectroscopic Surveys"
- Press release "Theorem unifies superfluids and other weird materials"
- 2010 Gruber Cosmology Prize to David Spergel and Eiichiro Komatsu of the WMAP team
- Workshop "Geometry and Physics of the Landau-Ginzburg Model"

July
- Press release "Inaugural Simons Investigator Award to Hirosi Ooguri"
- The BCS Prize to the Kavli IPMU building

August
- Press release "Clumpy structure of supernova explosions – A Subaru view of supernova explosion mechanism –"
- Press release "Ninth data release of Sloan Digital Sky Survey III"
- The Third PFS Collaboration Meeting
- Open Meeting for The Hyper-Kamiokande Project
- Press release "New findings on Type Ia supernovae: Non-standard birth for a standard candle"

September
- Press release "Rapidly rotating white dwarf stars as a solution to missing companion problem for Type Ia supernovae"
- Hitoshi Murayama received a letter of appreciation of Global Messengers of "Japan" Project, organized by Japanese government's National Policy Unit.
- Press release "Hyper Suprime-Cam ushers in a new era of observational astronomy"
- The Mathematical Society of Japan Geometry Prize to Yukinobu Toda
- Press release "The first evidence that a yellow supergiant became a supernova"

November
- Press release "Hirosi Ooguri chosen for the first fellow of the American Mathematical Society"
- Kunio Inoue won the Nishina Memorial Prize
- The Kavli IPMU joined the Belle II experiment
- Workshop "Homological Projective Duality and Quantum Gauge Theory"
- Workshop "Supernovae, Dark Energy and Cosmology"
- Brice Ménard named Maryland's outstanding young scientist of 2012

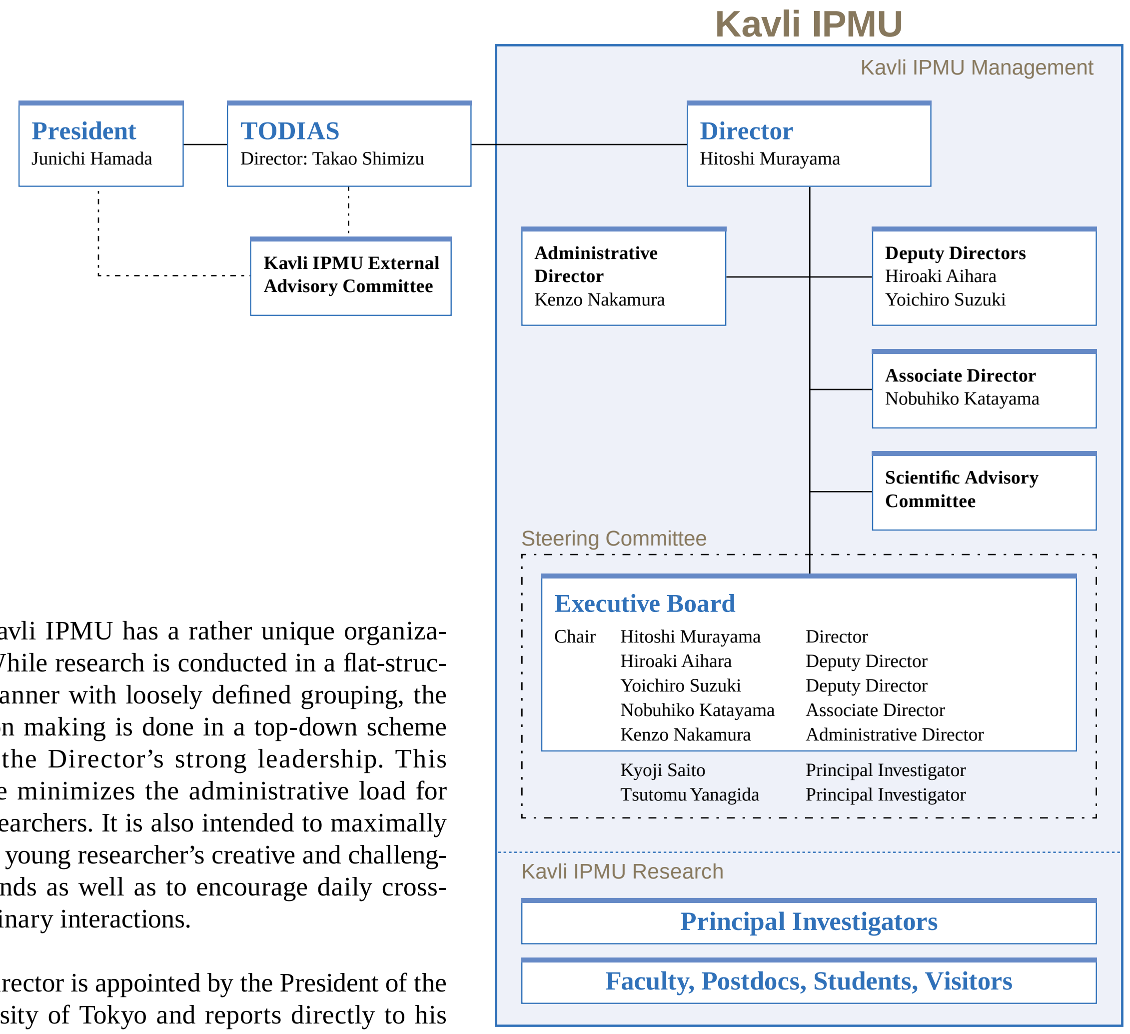
December
- Press release "Strict limit on CPT violation from gamma-ray bursts"
- Focus Week "Supernovae Near and Far"
- Press release "Shedding light on the power of M82's Superwinds"

January
- The 2012 Lancelot M. Berkeley Prize to Eiichiro Komatsu
- Second Open Meeting for the Hyper-Kamiokande Project
- Kavli IPMU-FMSP Tutorial Workshop "Geometry and Mathematical Physics"

February
- Focus Week "Gravity and Lorentz Violations"
- Press release "3-D Observations of the Outflow from an Active Galactic Nucleus"
- Press Release "Latest result on neutrinoless double beta decay at KamLand-ZEN "
- Hitoshi Murayama appointed to Deputy Director of the newly formed Liner Collider Collaboration

March
- Workshop "Exceptional Structures in Geometry and Conformal Field Theory"
- The Fourth PFS Collaboration Meeting
- The 2012 ASJ Young Astronomer Award to Masayuki Tanaka
- The 2012 PASJ Excellent Paper Award to Masahiro Takada
- The Yoji Totsuka Memorial Prize to Kunio Inoue

3 Organization



The Kavli IPMU has a rather unique organization. While research is conducted in a flat-structure manner with loosely defined grouping, the decision making is done in a top-down scheme under the Director's strong leadership. This scheme minimizes the administrative load for the researchers. It is also intended to maximally extract young researcher's creative and challenging minds as well as to encourage daily cross-disciplinary interactions.

The Director is appointed by the President of the University of Tokyo and reports directly to his office. The Director proposes to hire the Principal Investigators to the President. For other hiring of research staff and administrative staff, he has a complete authority. He is also solely responsible for making all other decisions. He is assisted by the two Deputy Directors, the Associate Director, and the Administrative Director. They hold the Executive Board (EB) regularly to ensure smooth operation of the Institute. The EB has direct access to the Office of the President for consultations on both scientific and administrative matters.

The Director is obliged to report the appointments of new Principal Investigators and faculty members to the Director of the Todai Institutes for Advanced Study (TODIAS). Also, to clear the university formality in faculty hiring, the decisions of the Institute have to be endorsed by the Steering Committee of the Kavli IPMU.

The Principal Investigators are world's leading scientists in their fields. They have a large autonomy in the research they conduct. They can make proposals to the Director to hire research staff at the Institute.

The Scientific Advisory Committee (SAC) gives advice to the Director on hiring scientific staff and setting scientific strategies. The members are appointed by the Director.

The External Advisory Committee (EAC), appointed by the President of the University of Tokyo, reviews annually the scientific achievement and activities of the Institute and advises the President on scientific priorities and the research activities to keep the Institute stay on the course of their objectives.

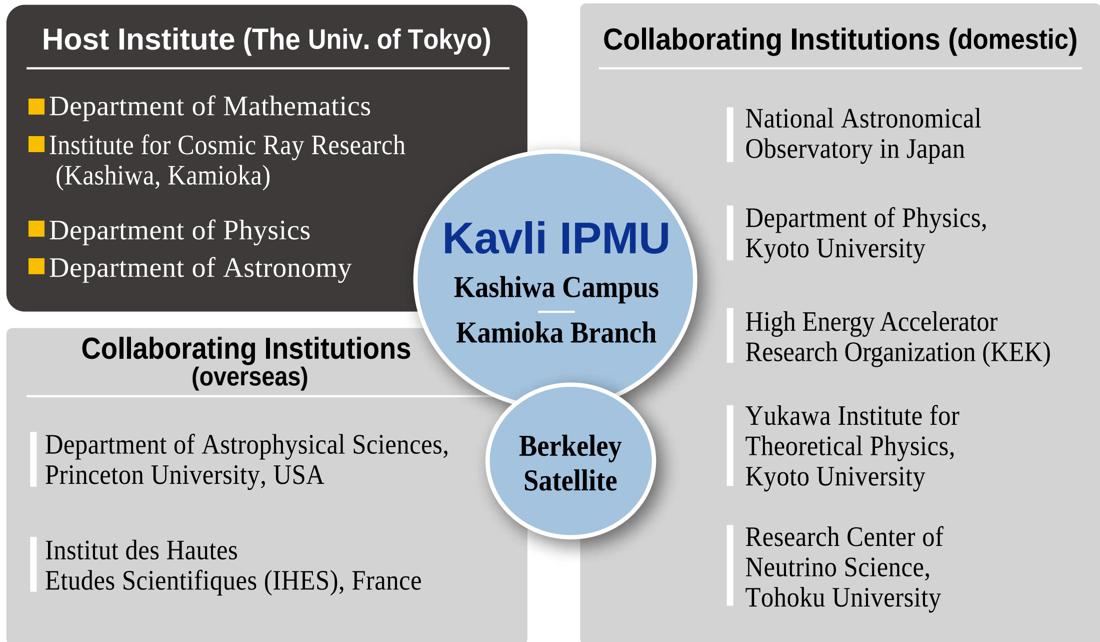
The Scientific Advisory Committee Members (March 2013)

Hiroaki Aihara	U of Tokyo Physics Dept	high energy physics
Yoichiro Suzuki	U of Tokyo, ICRR	astroparticle physics
Nobuhiko Katayama	Kavli IPMU	astrophysics
Toshitake Kohno	U of Tokyo Mathematics Dept	mathematics
Hirosi Ooguri	Caltech	particle theory
Kyoji Saito	Kavli IPMU	mathematics
David Spergel	Princeton U	astrophysics
Tsutomu Yanagida	Kavli IPMU	particle theory

The External Advisory Committee Members (March 2013)

John Ellis	CERN	particle theory
Steven Kahn	SLAC/Stanford U	astrophysics
Young-Kee Kim	Fermilab/U of Chicago	high energy physics
Sadayoshi Kojima	Tokyo Tech	mathematics
David Morrison	UC Santa Barbara	mathematics and physics
Sadanori Okamura	Hosei U	astronomy
Roberto Peccei	UCLA; Chair	particle theory
Nigel Smith	SNOLAB	astroparticle physics

The main laboratory building on the Kashiwa Campus provides a basis for our researchers. Even most of experimentalists who are involved in Kamioka experiments and astronomical observations spend a good fraction of their time in Kashiwa for analyzing data, sharing seminars and discussing with theorists. The Kamioka Branch is a basis for the Kavli IPMU staff members who are engaging in the Kamioka experiments. The Berkeley Satellite, besides being a place for research, serves as a contact place to the US scientific community. We also have a close collaborative relation with several institutions both in Japan and overseas as well as with other departments within the University of Tokyo.



The Kavli IPMU holds close relations with similar research institutions in the world for encouraging exchanges in research and training of young research staff. We have signed either an agreement or a memorandum of understanding with those institutions.

Foreign institutions/consortia/programs having MOU with the Kavli IPMU

The University of California, Berkeley, Department of Physics
National Taiwan University, Leung Center for Cosmology and Particle Astrophysics (LeCosPA)
The Astrophysics Research Consortium [on the Sloan Digital Sky Survey III]
Garching/Munich Cluster of Excellence on “The Origin and Structure of the Universe”
UNIFY (Unification of Fundamental Forces and Applications) [under the EU’s Seventh Framework Program]
The Scuola Internationale Superiore di Studi Avanzati (SISSA)
The Academia Sinica Institute of Astronomy and Astrophysics of Taiwan (ASIAA) [on the SuMIRe Project]
The Prime Focus Spectrograph Collaboration [including ASIAA, Brazil consortium, Caltech/JPL, Johns Hopkins Univ., Laboratoire d’Astrophysique de Marseille, Prinston Univ.]

Organization

4 Staff

Kavli IPMU research staff at the 5th anniversary celebration

Director

Hitoshi Murayama

Deputy Directors

Hiroaki Aihara
Yoichiro Suzuki

Associate Director

Nobuhiko Katayama

Principal Investigators

Hiroaki Aihara (U Tokyo-Phys), High energy physics, Astrophysics
Alexey Bondal (Kavli IPMU & Steklov Inst), Mathematics
Kunio Inoue (Tohoku U), Neutrino physics
Takaaki Kajita (U Tokyo-ICRR), Neutrino physics
Stavros Katsanevas (U Paris 7), Astroparticle physics
Toshiyuki Kobayashi (U Tokyo-Math), Mathematics
Toshitake Kohno (U Tokyo-Math), Mathematics
Hitoshi Murayama (Kavli IPMU & UC Berkeley), Particle theory, Cosmology
Masayuki Nakahata (U Tokyo-ICRR), Astroparticle physics
Mihoko Nojiri (KEK), Particle theory
Ken'ichi Nomoto (Kavli IPMU), Astronomy
Hirosi Ooguri (Caltech), Mathematics, String theory
Kyoji Saito (Kavli IPMU), Mathematics
Henry Sobel (UC Irvine), Astroparticle physics
David Spergel (Princeton U), Astrophysics
Naoshi Sugiyama (Nagoya U), Cosmology
Yoichiro Suzuki (U Tokyo-ICRR), Astroparticle physics
Tsutomu Yanagida (Kavli IPMU), Particle theory

Faculty Members

Tomoyuki Abe, Mathematics
Alexey Bondal, Mathematics
Kevin Bundy, Astronomy
Masataka Fukugita, Astrophysics
Simeon Hellerman, String theory
Takeo Higuchi, High energy physics
Kentaro Hori, String theory
Chang Kee Jung, High energy physics
Hiroshi Karoji, Astronomy (SuMIRe Project)
Nobuhiko Katayama, Astrophysics
Satoshi Kondo, Mathematics
Alexandre Kozlov, Neutrino physics
Alexie Leauthaud, Astrophysics
Keiichi Maeda, Astronomy
Kai Martens, Astroparticle physics
Shigeki Matsumoto, Cosmology
Todor Milanov, Mathematics
Shinji Mukohyama, Cosmology
Hitoshi Murayama, Particle theory, Cosmology
Ken'ichi Nomoto, Astronomy
Masamune Oguri, Cosmology (SuMIRe Project)
Kyoji Saito, Mathematics
John Silverman, Astronomy
Hajime Sugai, Astronomy (SuMIRe Project)
Shigeki Sugimoto, String theory
Masahiro Takada, Cosmology
Naoyuki Tamura, Astronomy (SuMIRe Project)
Yukinobu Toda, Mathematics
Mark Vagins, Astroparticle physics
Taizan Watari, String theory
Tsutomu Yanagida, Particle theory
Naoki Yasuda, Astronomy

Postdoctoral Researchers

Amir Babak Aazami, Mathematical physics
Melina Bersten, Astronomy
Jyotirmoy Bhattacharya, String theory
Biplob Bhattacherjee, Particle theory
Scott Carnahan, Mathematics
Yu-Chieh Chung, String theory
Tanmay Neelesh Deshpande, Mathematics
Richard Eager, Mathematical physics
Jason Evans, Particle theory
Brian Feldstein, Particle theory
Gaston Folatelli, Astrophysics
Sergey Galkin, Mathematics
Alexander Getmanenko, Mathematics
Ahmet Emir Gumrukcuoglu, Cosmology
Minxin Huang, String theory
Ivan Chi-Ho Ip, Mathematics
Tadashi Ishibe, Mathematics (JSPS Fellow)
Johanna Knapp, String theory
John Fotis Kehayias, Particle theory
Claire Nicole Lackner, Astronomy
Tsz Yan Lam, Astrophysics
Siu-Cheong Lau, Mathematics
Changzheng Li, Mathematics
Chunshan Lin, Cosmology
Jing Liu, Astroparticle physics
Sourav Mandal, Particle theory
Charles Milton Melby-Thompson, String theory
Rene Meyer, String theory
Anupreeta Sadashiv More, Astronomy (JSPS Fellow)
Surhud More, Astronomy
Satyanarayan Mukhopadhyay, Particle theory
Yu Nakayama, String theory
Katsuyuki Naoi, Mathematics
Takahiro Nishimichi, Astronomy (JSPS Fellow)
Atsushi Nishizawa, Astronomy (SuMIRe Project)
Takaya Nozawa, Astronomy (JSPS Grant)
Daniel Michael Pomerleano, Mathematics
Robert Michael Quimby, Astronomy
Mauricio Andres Romo Jorquera, String theory
Tomoki Saito, Astronomy (SuMIRe Project)
Cornelius Schmidt-Colinet, String theory
Kai Ruven Schmitz, Particle theory
Johannes Schmude, String theory
Christian Schnell, Mathematics
Malte Schramm, Astronomy
Charles Martin Siegel, Mathematics
Charles Steinhardt, Astronomy
Matthew Sudano, Particle theory
Masayuki Tanaka, Astronomy
Valentin Tonita, Mathematics
Shunsuke Tsuchioka, Mathematics (JSPS Fellow)
Mircea Voineagu, Mathematics
Benedetta Vulcani, Astronomy
Yi Wang, Cosmology
Marcus Werner, Mathematical physics
Simon Wood, Mathematics (JSPS Fellow)
Norimi Yokozaki, Particle theory (JSPS Fellow)

Support Scientists (SuMIRe Project)

Steven Jeffery Bickerton, Astronomy
Masahiko Kimura, Astronomy (Stationed at ASIAA)
Atsushi Shimono, Astrophysics

Joint Appointments

Alexey Bondal (Steklov Inst), Mathematics
Chang Kee Jung (Stony Brook U), High energy physics
Hitoshi Murayama (UC Berkeley), Particle theory, Cosmology

Affiliate Members

Kou Abe (U Tokyo-ICRR), Astroparticle physics
Mina Aganagic (UC Berkeley), String theory
Raphael Bousso (UC Berkeley), Cosmology
Scott Huai-Lei Carnahan (Tsukuba U), Mathematics
Patrick Decowski (NIKHEF), Neutrino physics
Mamoru Doi (U Tokyo-Astron), Astronomy
Yuri Efremenko (U Tennessee), Neutrino physics
Tohru Eguchi (Kyoto U-YITP), Field theory
Motoi Endo (U Tokyo-Phys), Particle theory
Sanshiro Enomoto (U Washington), Neutrino physics
Andrea Ferrara (S.N.S. Pisa), Astronomy
Brian Fujikawa (LBNL), Neutrino physics
Masaki Fukushima (U Tokyo-ICRR), Astroparticle physics
Kaoru Hagiwara (KEK), Particle theory
Lawrence Hall (UC Berkeley), Particle theory
Koichi Hamaguchi (U Tokyo-Phys), Particle theory
Tetsuo Hatsuda (U Tokyo-Phys), Particle theory
Yoshinari Hayato (U Tokyo-ICRR), Neutrino physics
Masashi Hazumi (KEK), Astrophysics
Karsten Heeger (U Wisconsin), Neutrino physics

Katsuki Hiraide (U Tokyo-ICRR), Astroparticle physics
Raphael Hirschi (U Keele), Astronomy
Junji Hisano (U Tokyo-ICRR), Particle theory
Petr Horava (UC Berkeley), String theory
Glen Horton-Smith (U Kansas), Neutrino physics
Shinobu Hosono (U Tokyo-Math), Mathematical physics
Masahiro Ibe (U Tokyo-ICRR), Particle theory
Ken'ichi Izawa (Kyoto U-YITP), Particle theory
Hiroshi Kaji (U Tokyo-ICRR), High energy physics
Jun Kameda (U Tokyo-ICRR), Neutrino physics
Amanda Irene Karakas (Australian NU), Astronomy
Masaki Kashiwara (Kyoto U-RIMS), Mathematics
Akishi Kato (U Tokyo-Math), Mathematical physics
Yasuyuki Kawahigashi (U Tokyo-Math), Mathematics
Seiji Kawamura (U Tokyo-ICRR), Astroparticle physics
Masahiro Kawasaki (U Tokyo-ICRR), Cosmology
Edward Kearns (Boston U), Neutrino physics
Sergey Ketov (Tokyo Met U), Cosmology
Nobuhiro Kimura (KEK), Gravity
Yasuhiro Kishimoto (U Tokyo-ICRR), Neutrino physics
Chiaki Kobayashi (U Hertfordshire), Astronomy
Kazuyoshi Kobayashi (U Tokyo-ICRR), Astroparticle physics
Masayuki Koga (Tohoku U), Neutrino physics
Eiichiro Komatsu (U Texas (to 2012/05), Max Planck Inst Astropysics (from 2012/06)), Cosmology
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Takeo Moroi (U Tokyo-Phys), Particle theory
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Tsuyoshi Nakaya (Kyoto U), High energy physics
Kazunori Nakayama (U Tokyo-Phys), Particle theory
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Hiroshi Ogawa (U Tokyo-ICRR), Astroparticle physics
Kimihiro Okumura (U Tokyo-ICRR), Neutrino physics
Yoshiyuki Onuki (U Tokyo-Phys), High energy physics
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Serguey Petcov (SISSA), Particle theory
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Fedor Smirnov (U Paris 6), Mathematics
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5 Research Program

5.1 Alternative Gravity Theories

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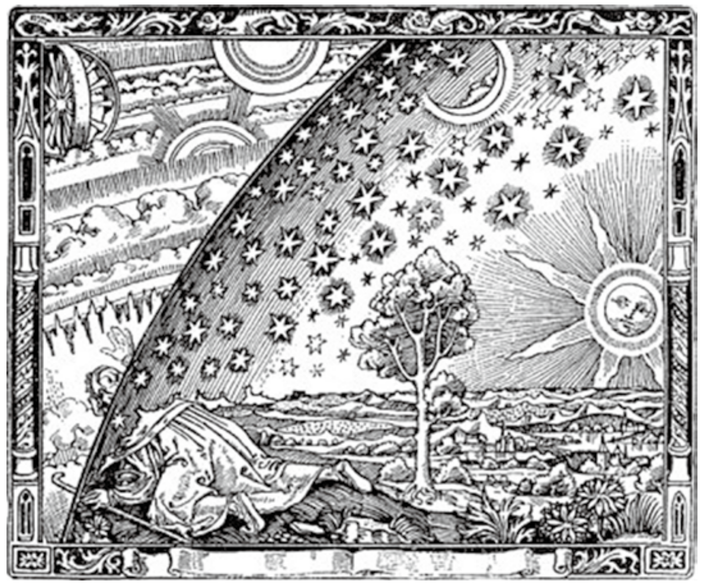
Einstein's theory of relativity unifies a 3-dimensional space and a 1-dimensional time as a spacetime and describes gravity as a fabric of curved spacetime. This picture has been very successful in explaining and predicting many gravitational phenomena. Experimentally, however, we do not know how gravity behaves at distances shorter than 0.01 mm. At shorter distances, gravity may behave completely differently from what we expect. For example there may be hidden dimensions at short distances. In fact, many theories, including superstring theories and M-theory, require the existence of such extra dimensions. Extra dimensions may exist everywhere in our universe, but they are somehow hidden from us. One possibility recently investigated very actively is called the brane-world scenario. In this scenario our universe is supposed to be a 3-dimensional surface, called brane, floating in higher-dimensional space. Although we cannot see extra-dimensions directly, we may hope to detect some indirect evidence of extra-dimensions in high-energy experiments or cosmological observations.



A traveller puts his head under the edge of the firmament (sky) in the original (1888) printing of the Flammarion engraving (taken from WIKIPEDIA).

Gravity at very long distances (for example, billions of light-years) may also be as weird as at short distances. Precision observational data recently revealed that the expansion of our universe is accelerating. If Einstein's theory is correct, this requires that more than 70% of our universe is filled with invisible, negative pressure, energy. This energy is named dark energy, but we do not know what it really is. This situation reminds us of a story in the 19th century: when the perihelion shift of Mercury was discovered, some people hypothesized the existence of an invisible planet called Vulcan, a so-to-speak dark planet, to explain the anomalous behavior of Mercury. However, as we all know, the dark planet was not real and the correct explanation was to change gravity, from Newton's theory to Einstein's. With this in mind, the Alternative Gravity Theories Group wonder if Einstein's theory at long distances can be changed to address the mystery of dark energy.

5.2 Astroparticle Physics

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Brian Feldstein
Andrea Ferrara
Karsten Heeger
Junji Hisano
Ayuki Kamada
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John Kehayias
Alexandre Kozlov
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Chunshan Lin
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Kai Martens
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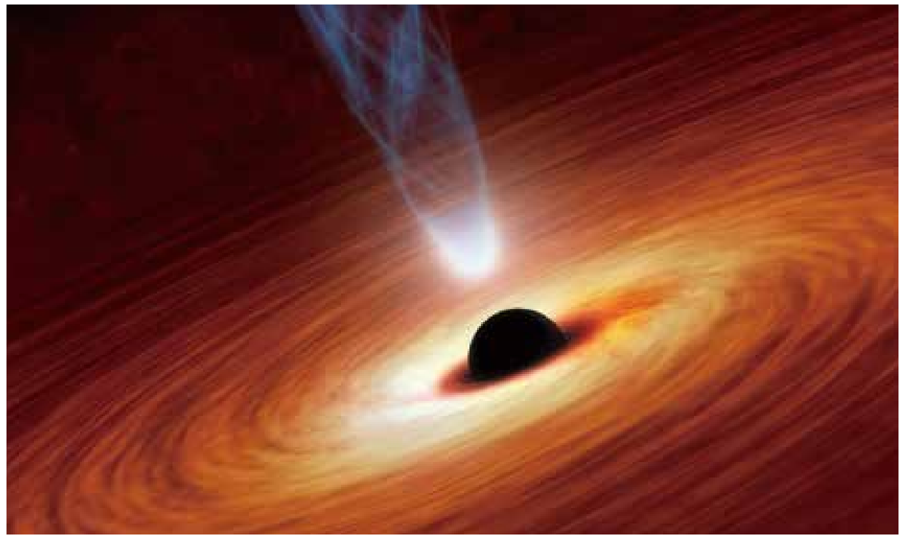
James Stone
Yoichiro Suzuki
Masahiro Takada
Mark Vagins
Tsutomu Yanagida
Naoki Yoshida

High-energy phenomena naturally occurring in the universe provide a wealth of data and new valuable insights into particle physics and cosmology. The Kavli IPMU researchers use the universe as a laboratory for testing new theories of dark matter and new physics beyond the Standard Model, and for understanding the basic properties of the universe. In the past year, several exciting developments in particle astrophysics were initiated by the Kavli IPMU members.



Artist's conception of a supermassive black hole in the center of an active galaxy.
Credit: NASA.

Dark Matter

Its existence is supported by a substantial body of astrophysical evidence, but the identity of the dark matter particle (or particles) remains a mystery. Since one does not know the interactions of dark matter particles, besides their gravitational interactions, one must pursue a broad range of possibilities.

Dark matter plays a crucial role in formation of cosmic structures, such as galaxies, clusters of galaxies, etc. Astronomical observations of such structures on the largest scales have helped one narrow down the possibilities for dark-matter particles. Ongoing astronomical observations may provide some additional clues regarding the physical properties of dark matter. The interdisciplinary nature of the Kavli IPMU makes it a perfect place for a multi-faceted, comprehensive effort to understand dark matter from both the astrophysical side and the particle physics side. Kamada and Yoshida, and their collaborators, studied how the structures on the scales smaller than a galaxy would be affected by the so called *warm* dark matter in the form of, e.g., sterile neutrinos. At the same time, Ibe, Kamada, and Matsumoto explored the signatures of non-thermally produced supersymmetric dark matter on the cosmic structures.

In another example of synergy between particle physics and astrophysics, Loewenstein, Kusenko, and Yanagida have proposed a new dark matter candidate and conducted a search for this form of dark matter using some dedicated observations with Suzaku, a Japanese X-ray telescope in space. Light scalar fields called moduli arise from a variety of different models involving supersymmetry and string theory, and they present a formidable, long-standing problem for cosmology: generically, they appear to dominate dramatically over all the rest of the species in the universe. A new solution to this problem, supported by the discovery of a 125 GeV Higgs boson, automatically leads to dark matter in the form of moduli particles. This form of dark matter is consistent with the observed properties of structure formation, and it is amenable to detection with the help of X-ray telescopes. The first observations of the Draco and Ursa Minor dwarf spheroidal galaxies have not produced a detection, but more observations are planned in the near future.

An intriguing possibility is that both dark matter and ordinary matter arise from the same process in the early universe, in which supersymmetric fields form a condensate that splits into lumps called Q-balls, which play an important role in generating a population of dark matter particles, as well as matter-antimatter asymmetry of the universe. The common origin of dark matter and ordinary matter may be the key for understanding why the amounts of the two types of matter in the universe are not very different. This appealing scenario has led Kamada, Kawasaki, and Yamada to predict that dark matter could be the supersymmetric partner of the *W* boson.

Heavy gravitino dark matter can emerge from cosmological inflation naturally in a model proposed by Kawasaki, Kitajima, Nakayama, and Yanagida.

Henning and Murayama have examined the effects of relic dark matter annihilations on the predictions of big bang nucleosynthesis, which can be a sensitive probe of new physics. Annihilation of dark matter particles with a relatively low mass can disrupt the formation of nuclei in the early universe. Henning and Murayama derived some very strong constrains on the properties of dark-matter particles, which help narrow down the range of possibilities.

Bhattacherjee, Choudhury, Harigaya, Matsumoto, and Nojiri performed a model independent analysis of dark matter interactions with quarks, addressing an issue that is important for searching for dark-matter particles at Large Hadron Collider.

Black holes, big and small

The appealing possibility that black holes can form in the early universe was investigated by Kawasaki, Kitajima, and Yanagida. Curvaton cosmology can produce black holes with different masses. Black holes with masses ~ 10^{20} – 10^{38} g can account for dark matter in the universe, while more massive black holes, about 10^5 solar masses, can serve as seeds of supermassive black holes observed in the centers of galaxies, including Milky Way.

The largest supermassive black holes, with masses of hundred million solar masses and beyond, are the most powerful sources of radiation in the universe. These giant black holes absorb gas and stellar matter in the centers of active galaxies, spewing very high energy gamma rays and cosmic rays, which are accelerated in their powerful jets. The origin of these supermassive black holes is a long-standing unsolved problem, which may be solved by the 10^5 solar mass primordial seeds created by inflation.

TeV gamma rays from supermassive black holes in remote galaxies cannot travel large distances because they lose energy in interactions with starlight and infrared light re-emitted by dust. Yet, some very energetic gamma rays have been observed from some very distant objects. This created a puzzle. Lorentz invariance violation, as well as the existence of axion-like particles mixed with the photon, have been considered as possible explanations. However, Kusenko and collaborators showed that the observed spectra, as well as their relatively mild dependence on the redshift, can be explained by the secondary gamma-rays, which did not originate at the source, but were produced in the cosmic ray interactions along the line of sight. This interpretation paves the way for measuring magnetic fields deep in the voids between galaxies, where the primordial seed fields may have existed from the time of Big Bang. Furthermore, one can measure correctly the extragalactic background light, which reveals the history of star formation in the universe.

High-energy neutrinos

PeV neutrinos, the most energetic neutrinos ever detected, were recently discovered by the IceCube collaboration. Their origin is a mystery, especially because they appear to have a relatively narrow spectrum. The Kavli IPMU researchers have pursued two exciting possibilities: that these neutrinos originate from supermassive black holes, and that they come from decays of very massive dark-matter particles. New data, expected later this year, will help interpret this exciting discovery and its ramifications for astroparticle physics.

5.3 Collider Phenomenology

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Koji Ichikawa
Keisuke Harigaya
John Kehayias
Alexander Kusenko
Sourav Mandal
Shigeki Matsumoto
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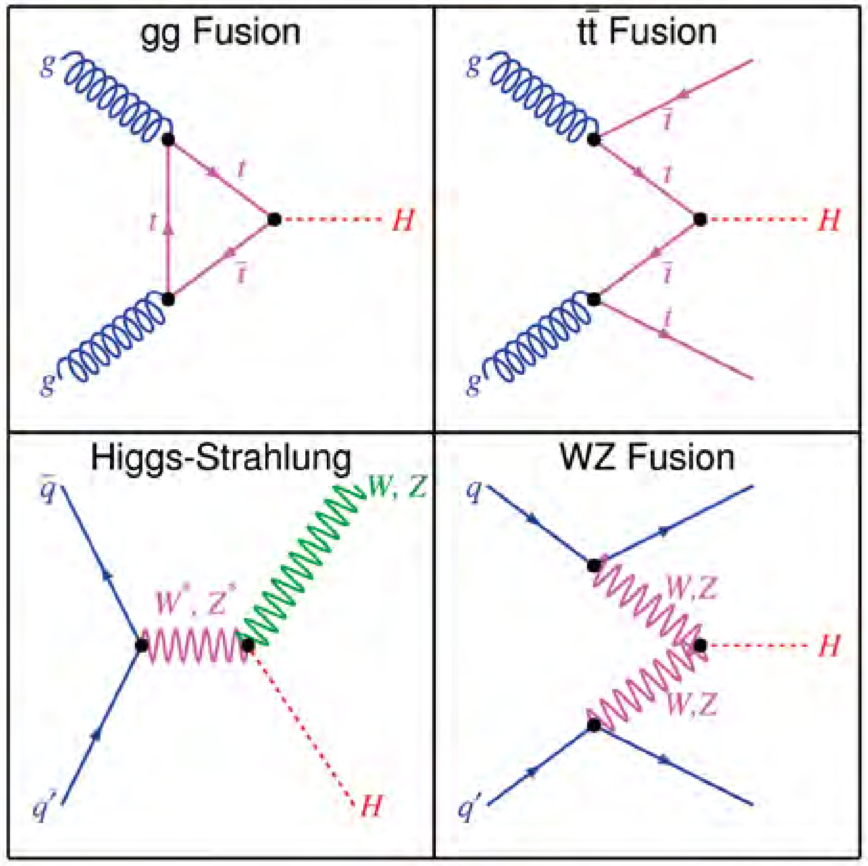

Credit: CDF Collaboration

Collider phenomenology is now one of the most important research-programs in particle physics because the CERN Large Hadron Collider (LHC) experiment has been running since autumn 2009. In fact, the LHC experiment has been providing many precious data on the studies of the standard model (SM) and physics beyond the SM, and those are being used to test various models of particle physics. The members of the Kavli IPMU collider phenomenology group have therefore great opportunities in exploring these physics, and pursue a broad range of research.

The LHC experiment enables us to systematically investigate the electroweak symmetry breaking, to study quantum chromodynamics (QCD), and to probe new physics beyond the SM. Among several researches of collider phenomenology, most of the members in the group are studying physics beyond the SM such as

- Low energy supersymmetry,
- Extra-dimensions at low energy-scale,
- Composite Higgs (Little Higgs, etc.),
- Other unexpected exotics.

The LHC experiment is currently suggesting the existence of the higgs boson at about 125 GeV, while no new physics signals have been discovered yet. These results are (and will be) used to have a deep understanding of physics beyond the SM at the TeV energy-scale.

It is also worth emphasizing that the study of the collider phenomenology at the Kavli IPMU has several advantages, because the study is directly and indirectly influenced by other research-programs. Connections between the study of collider phenomenology and those of model buildings of particle physics, dark matter searches, and cosmology are particularly of importance. As already mentioned in this report of other research-programs, the Kavli IPMU has many active researchers working on these topics. It is thus possible for the members of the group to efficiently perform their studies.

In addition to collider phenomenology at the LHC experiment, some of the members are also studying those at other collider experiments which are planned in near future. They are especially interested in the studies of physics beyond the SM at High Luminosity-LHC (HL-LHC) experiment and future linear collider experiments such as the International Linear Collider (ILC) and Compact Linear Collider (CLIC).

5.4 Cosmology and Statistics

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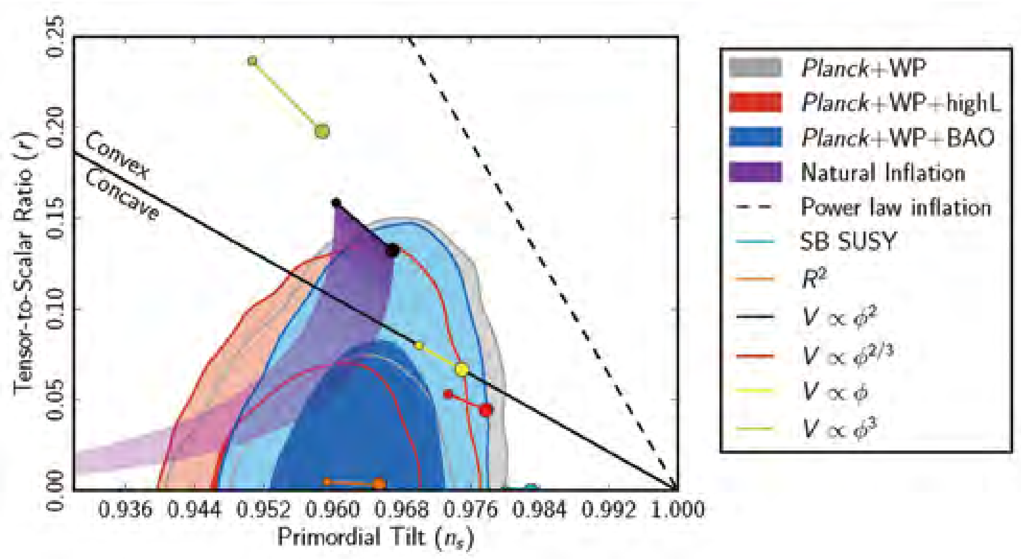

Marginalized 68% and 95% confidence levels for n_S, and r from Planck+WP and BAO data, compared to the theoretical predictions of selected inflationary models. Credit: Planck Collaboration

Recent remarkable progress in cosmology is driven by vast observational data. Statistical analysis of these observational data constitutes an essential part of studies to explore physics behind the history and structure of the Universe. In particular, proper use of statistical quantities is a central issue of cosmology, because cosmological information is encoded in the fluctuations of the spatial distributions of astronomical objects. While the initial fluctuations are known to follow Gaussian statistics, fluctuations in the present Universe are quite non-Gaussian as a consequence of the evolution of the fluctuations via the gravitational instability, characterization of which requires the higher order statistics beyond the two-point correlation function. This is a highly mathematical problem and is also one of the main themes in the research program of the Cosmology and Statistics Group at the Kavli IPMU.

Another important problem in the comparison between theoretical models and observations is efficient parameter inference and model selection based on statistics. For example, Markov chain Monte Carlo methods and Bayesian statistics have been introduced to cosmological analysis relatively recently, which significantly advanced analysis of cosmological data. New large-area surveys such as Subaru HSC/PFS will increase a tendency for applying sophisticated statistical techniques to the observational data. At the Kavli IPMU, cosmologists and mathematicians work together to tackle this problem and explore possible applications of new statistical techniques to cosmological analysis.

5.5 Dark Matter Experiment

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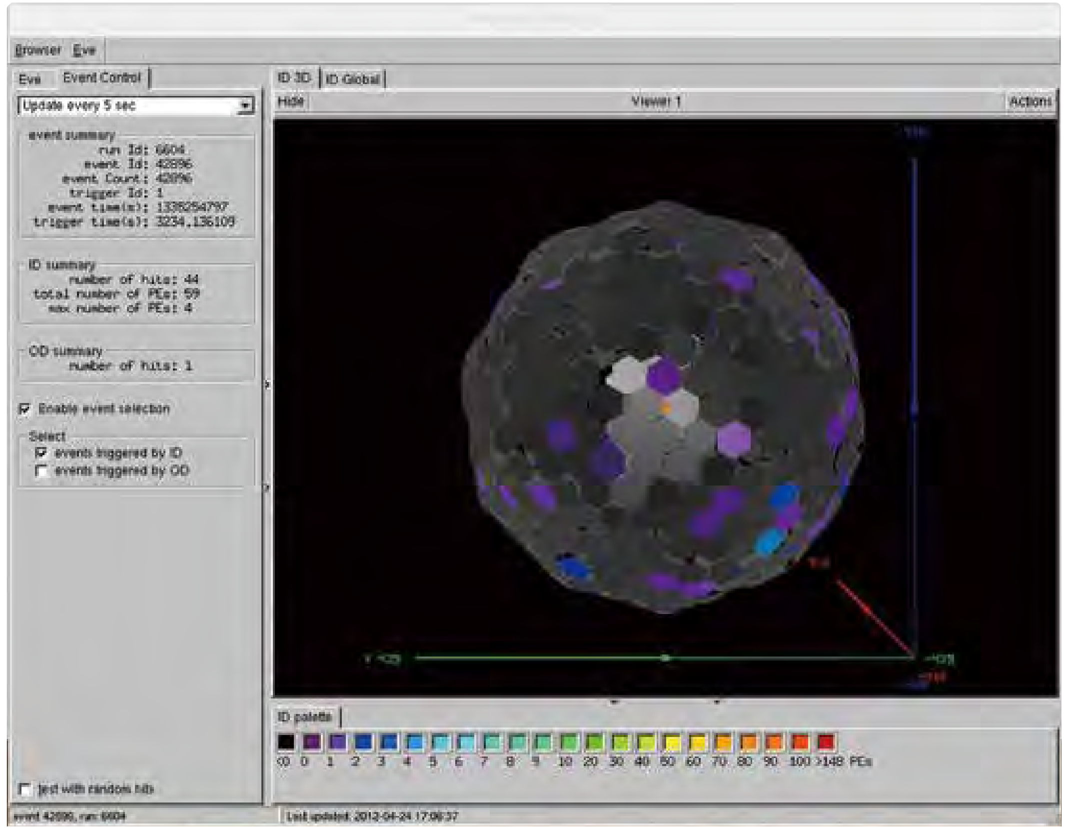


A 23% of all there is in the Universe is what we call Dark Matter. Dark because unlike normal matter (4% of all there is) it does not interact with light. So we cannot see it with our telescopes, although we can clearly see its imprint on the distribution and movement of the visible stars and galaxies through gravitational forces among them. But while in this way we can even map its distribution throughout the accessible history of our universe, we have no clear hints yet as to its true nature.

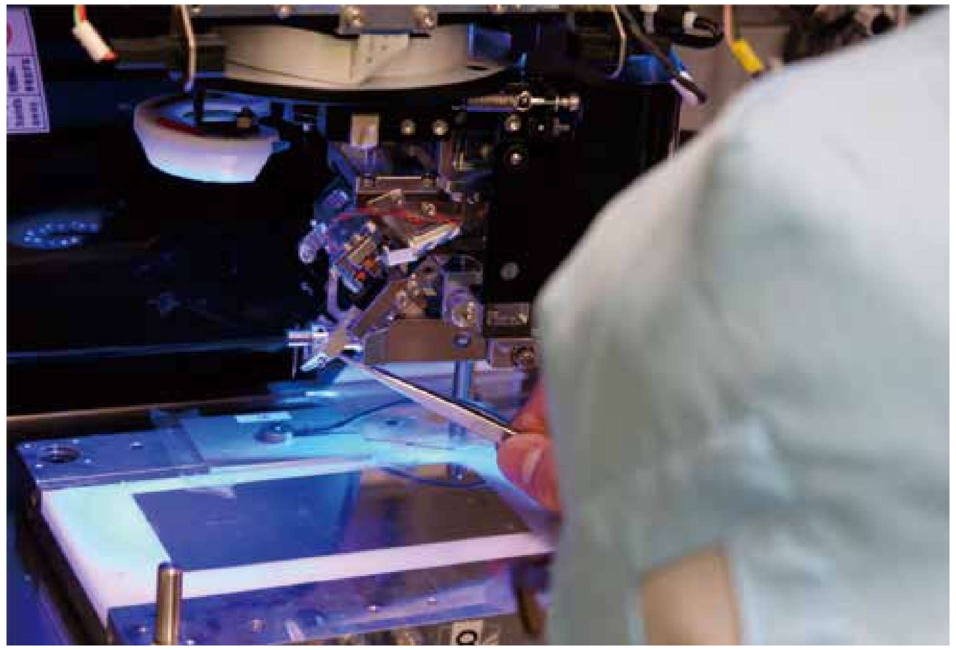
One possibility is that Dark Matter takes part in the weak interaction of particle physics. As this particular possibility is very attractive also from the point of view of particle theory, it has given rise to a variety of dedicated experiments around the world. WIMP has become the shorthand for this type of Dark Matter: Weakly Interacting Massive Particle.

The Kavli IPMU is involved in this effort through the XMASS experiment at its Kamioka branch. In the XMASS detector one metric ton of xenon is kept as a liquid at minus 100 degree Celsius. The dense liquid provides both a large target mass at its center as well as shielding against radioactive backgrounds. Fast neutrons from the surrounding rock are moderated and remaining muons tagged in an 800 ton active water shield in which the detector is immersed.

The first data was taken in fall 2011. After several improvements and further tuning of the detector system, the detector would become the world's most sensitive detector for the direct detection of dark matter particles in our galaxy.

5.6 Detector Developments

Sanshiro Enomoto, Alexandre Kozlov, Hajime Sugai, Karsten Heeger, Jing Liu, Ryutaro Takahashi, Takeo Higuchi, Kai Martens, Yasuo Takeuchi, Glenn Horton-Smith, Andreas Piepke, Naoyuki Tamura, Ken'ichi Izawa, Hiroyuki Sekiya, Mark Vagins



Experimental physics and observational astronomy rely on cutting-edge technologies to build detectors that push the frontier of knowledge with the data they deliver. Data is the lifeblood of science, as the scientific method demands that every insight be tested against the hard evidence of experimental data. The art of experimentation is to provide both reliable and pertinent data to test the theories that the disciplined use of knowledge and imagination conjure from the massive body of scientific data already accumulated.

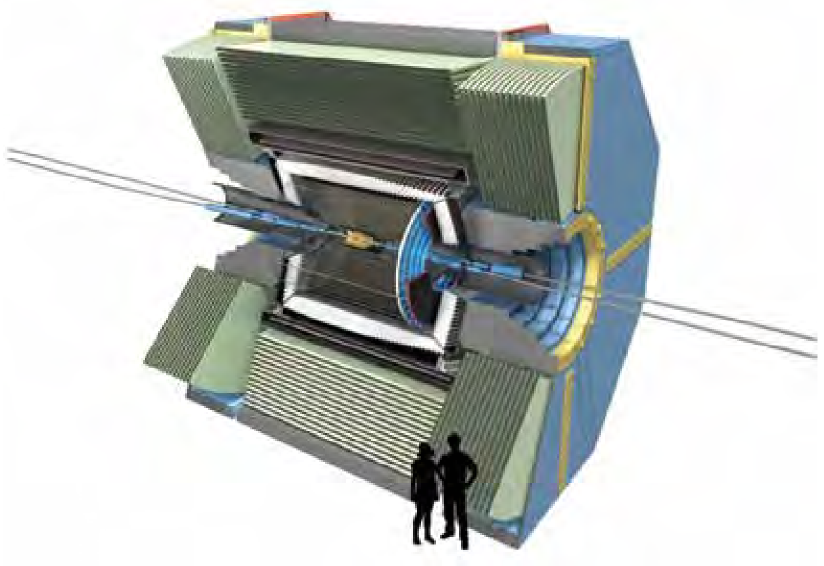
Active detector development provides the means to extend the reach of current and future experiments – and very possibly new technology that may well find its way back into your living room or workshop. It is a vital ingredient in our quest to understand the Universe.

The detector developments that are taking place at the Kavli IPMU are as diverse as the problems encountered and the individuals working on them.

- Developing a reliable scheme to add water-soluble gadolinium into the ultra-pure water volume of Super-Kamiokande. If successful, it can drastically lower the energy threshold and background for the detection of supernova relic neutrinos.
- Developing an innovative purification method of a large-volume liquid noble gas such as Argon and Xenon. These gases are used for the time projection chambers in future measurements of dark matter and neutrinos.
- Developing a multi-object spectrograph that uses optical fiber for the Subaru telescope. It allows spectroscopic analysis of many galaxies simultaneously and, therefore, is a powerful tool for large-scale galaxy survey.
- Developing techniques for assembling and optimizing the silicon vertex detector that measures the decay vertices of *B* mesons with high resolution. Success of the Belle II experiment heavily relies on this R&D.
- Exploring ways to significantly improve the sensitivity for the dark matter search: developing high-purity germanium detector, developing techniques for coupling the photomultiplier tube with the scintillating crystals such as sodium iodide and cesium iodide at the liquid nitrogen temperature, and developing a dark matter detector module based on ultra-pure NaI(Tl) crystals.

5.7 Heavy Flavor Physics

Takeo Higuchi, Yoshiyuki Onuki



An illustration of the Belle detector
(Credit: Rey.Hori/KEK)

Success of the Belle experiment at KEK was highlighted by an overwhelming confirmation of Kobayashi-Maskawa mechanism for CP violation in 2001, for which the two were awarded the 2008 Nobel Prize. It established that the CP violation arises from the quark mixing in the Standard Model. However, somewhat under-stressed but equally important accomplishments by this experiment was to over-constrain the Cabibbo-Kobayashi-Maskawa unitary matrix through high precision measurements of a variety of *B*-meson decays, providing a detailed phenomenological description of the flavor sector in the Standard Model.

Although the statistics is limited, some of these measurements seem to be deviated from the Standard Model prediction. They suggest possible existence of a hidden mechanism at a high energy scale. It is also pointed out by several other experimental and theoretical studies.

Flavor physics has provided several critical breakthroughs in the history of establishing the Standard Model. In particular, the Flavor-Changing Neutral Current (FCNC) processes, which appear only in quantum loop corrections, proved powerful for observing effects of heavier particles. Study of *B*-meson decays is a natural place to investigate a wide range of the FCNC processes because the *b* quark belongs to the third generation and hence its decay is involved with all existing generations of quarks. Powerfulness of flavor physics to elucidate physics beyond the Standard Model should be fully exploited, and this situation remains the same even after energy frontier machines discover new particles. In addition to the *B*-meson decay studies, search for a lepton-flavor violating decay in τ-lepton decays is also important. The lepton-flavor violating decay is highly suppressed within the Standard Model, but a new physics may enhance the process to a detectable level. Specifically one needs to address:

- Is there any new CP-violating phase?
- Is there any new right-handed current?
- Is there any effect from new Higgs fields?
- Is there any new flavor violation such as lepton-flavor violation?
- Is there any new flavor symmetry that explains the CKM hierarchy?

The Belle II experiment at the SuperKEKB accelerator offers an excellent opportunity for further exploration into flavor physics. The SuperKEKB is an asymmetric-energy e^+e^- collider, expected to be commissioned in 2014. It operates at the Υ(4S)-resonance energy with the luminosity 40 times higher than the KEKB accelerator and produces 50 times more *B* and anti-*B*-meson pairs in a boosted center-of-mass frame. The boost allows to measure the decay time of each *B* meson. The original Belle detector is being upgraded into Belle II so that it can maximally exploit the high luminosity operation of the SuperKEKB.

At the moment, the Kavli IPMU team plays a central role for assembling the silicon vertex detector that is used to measure the decay vertices of *B* mesons. Once the construction period is over, the group will study a wide range of subjects in flavor physics and search for a hint of new physics beyond the Standard Model.

5.8 Inflation and Early Universe

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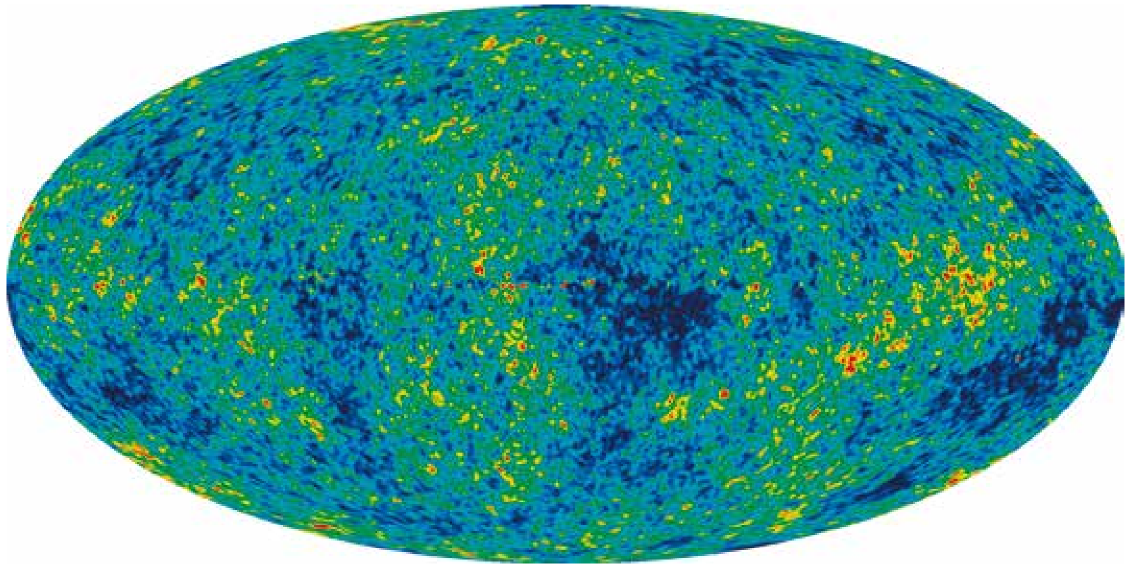
John Kehayias
Alexander Kusenko
Chunshan Lin
Shinji Mukohyama
Yasunori Nomura
Charles Steinhardt
Masahiro Takada
Yi Wang
Taizan Watari
Tsutomu Yanagida
Jun'ichi Yokoyama



Credit: NASA/WMAP Science Team

The Universe is expanding; the further away a galaxy is, the faster it is moving, which is known as the Hubble's law. This observational fact implies that, if we go back in time, the Universe was small, dense and extremely hot. The evolution of the early universe is described by the Friedmann-Lemaitre-Robertson-Walker (FLRW) universe, a homogeneous and isotropic solution of the Einstein equations of the general relativity, and the standard big bang theory is based on the FLRW universe. The Hubble's law, the big bang nucleosynthesis (BBN), the comic microwave background (CMB) radiation provide key support for the standard big bang theory. Those three observations still remain important probes of the early Universe.

Despite its great success the big bang theory is plagued with serious theoretical issues such as the horizon problem, the flatness problem, and the monopole problem. Those problems are beautifully solved by introducing an inflationary expansion at the very early stage of the Universe. What is more important about inflation is that quantum fluctuations of a scalar field driving the inflation (called an inflaton) generate tiny density perturbations, which can account for the seed of the structures such as galaxies and clusters of the galaxies seen in the current Universe. The properties of the density perturbations depend on the inflation models, which can be probed by studying tiny inhomogeneities in the CMB temperature anisotropy.

The recent progress in observational techniques has enabled us to study the evolution of the early universe with unprecedented precision, and our understanding of the Universe has significantly increased. Nevertheless it is not fully known how the inflation occurred, how the universe was reheated after inflation, how the dark matter as well as the baryon asymmetry was created, whether there is large non-Gaussianity in the density perturbations or not, and so on. The Inflation and Early Universe Group would like to tackle those questions in order to reveal how the universe evolved from the inflationary epoch into what it looks like at present.

5.9 Mathematics

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Tomoyuki Abe
Alexey Bondal
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Richard Eager
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Mauricio Romo
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Christian Schnell
Charles Martin Siegel
Fedor Smirnov
Yuji Tachikawa
Atsushi Takahashi
Yukinobu Toda
Valentin Tonita
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Marcus Werner
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One can say that the history of mathematics is more or less equivalent to the history of mankind attacking problems in reason or knowledge. Mathematics abstracts the truth behind generalities. It began as a useful tool in everyday physics in the sense that we count numbers, we measure length and volume. Then as seen in Euclidean geometry of Euclid or in the problem of determining the existence or non-existence of roots in algebraic equations, the practical side became lost and mathematics becomes pure pursuit of knowledge of human kind. Diophantine equations, Fermat's lifework, do not affect our life at all whether they had integral solutions or not.

In the 17th century, Newton found differential and integral calculus, giving a language and method to describe the law of dynamics in nature, so then mathematics encountered physics. This is a good example of mathematics providing the scientific community, and sometimes society in general, with a common language and method to describe phenomena in their study. This in turn helps to establish mathematician's original concepts. Particularly in recent years the interaction between mathematics and physics has been in full flow.

This interaction is more important than ever, and mathematics of the 20th century developed through an enormous influence from physics. Gauge theory, quantum field theory, general relativity, and superstring theory in physics have provided major impetus in the field of mathematics such as algebraic geometry, differential geometry, topology, representation theory, algebraic analysis, and number theory.

Although the influence is great, mathematicians have been and will be working on those problems in mathematics which arose, and are to be solved purely within mathematics. A prominent recent example is the resolution of Fermat's last theorem. Notably, there exist examples where those tools developed purely mathematically have interesting applications in physics.

The Kavli IPMU is a very exceptional research environment for mathematicians, in that there always are physicists nearby. The mathematicians at the Kavli IPMU are to develop both physics and mathematics through much discussion with the physicists. However, the emphasis is on that the true interest of mathematics is in mathematics, so the researchers undertake their research with their top priority in the field of mathematics.

Geometry:

Geometry is a collection of branches of mathematics, which studies mathematically defined geometric objects. For instance, geometric objects include topological spaces, differentiable manifolds, Riemannian manifolds, symplectic manifolds, complex manifolds, and algebraic varieties. These are not only geometric figures but also have important mathematical structures, which make the theories behind them very rich. Also the geometry plays an important role in describing our universe, and has contributed much to physics. For instance, Riemannian geometry is necessary in developing Einstein's theory of general relativity. On the other hand, by the influence of string theory, it has been found recently that there are deep connections among these geometric theories. The most significant example is the mirror symmetry, which predicts a duality between symplectic manifolds and algebraic varieties. These have been developed as different mathematical fields, but are now expected to be equivalent by the duality between the two different types of string theories. The mirror symmetry is one of the themes of the study of geometry at the Kavli IPMU.

In the theory of mirror symmetry, a Calabi-Yau 3-fold plays an important role. It is an algebraic manifold of complex dimension three (real dimension six), with a Ricci flat metric. In string theory, our universe is considered to be 10 dimensional, and a Calabi-Yau 3-fold appears as an extra six dimensional space. The mirror symmetry predicts an equivalence between period integrals on a Calabi-Yau 3-fold and a curve counting theory (Gromov-Witten theory) on its mirror manifold. At the Kavli IPMU, there are specialists in each side, and the mirror symmetry is studied vigorously. K. Saito has studied the theory of periods for a long time, and found the notion of Frobenius structures on the deformation spaces of the singularities. This Frobenius structure is now an essential tool in describing the mirror symmetry. T. Milanov is an expert in Gromov-Witten theory, and studies the Frobenius structures determined by Gromov-Witten invariants.

Another way to describe the mirror symmetry is to use the homological algebra. This was proposed by Kontsevich in 1994, and it is formulated as an equivalence between the derived category of coherent sheaves on a Calabi-Yau 3-fold and the derived Fukaya category on its mirror manifold. A. Bondal is a leading expert in derived categories of coherent sheaves, and invented the notions of exceptional collections, enhancement of the derived category. These notions are now essential in the study of derived categories. Y. Toda studies stability conditions on derived categories, and Donaldson-Thomas type invariants counting stable objects in the derived categories. This corresponds to "BPS state counting" in string theory, and an interesting research subject also in string theory.

The study of the geometry at the Kavli IPMU does not restrict to the mirror symmetry, and the geometry is studied from various viewpoint. T. Kobayashi studies the action of discrete groups on non-Riemannian homogeneous spaces, and develops an original theory from a new geometric viewpoints. He discovered that local rigidity may fail even in higher dimensions for indefinite-Riemannian symmetric spaces, and is challenging to develop spectral theory in connection with their deformation theory. Also T. Kohno studies quantum invariants on low dimensional manifolds, which are related to integrable systems and the conformal field theory. He revealed a quantum group symmetry for homological representations of braid groups and described the image of quantum representations of mapping class groups. In this way, there are various studies of the geometry at the Kavli IPMU, and the Mathematics Group aim to have a further breakthrough by combining these studies.

Algebra:

Algebra was originally the field of mathematics that studied numbers and equations. In fact, in the Middle Ages, a central problem in algebra was solving algebraic equations of higher degrees.

In the 19th century, Évariste Galois discovered a symmetry hidden in such equations, which led to the invention of the notion of a group. After this discovery, the focus of the field of algebra shifted to understanding deep hidden structures.

Homological algebra is one such example. Homological algebra stems from geometry and was originally a way to count the number of holes of, say, doughnuts. Once geometric notions are abstracted to homological algebra, many new invariants which do not necessarily have an obvious geometric interpretation appear naturally. Derived categories are one such example. Derived categories were originally invented as a tool for efficiently computing (co)homologies, but today they are considered interesting in their own right. Mathematicians at the Kavli IPMU are pursuing a number of interests in the field of derived categories. For example, one question of interest is how much information on a given variety the derived category of coherent sheaves over that variety possesses. This question is currently – with the relation to mirror symmetry in mind – being actively studied by A. Bondal and Y. Toda, as was written in Geometry section above. The Mathematics Group are also trying to construct additional frameworks, such as differential graded algebra for example, to encode more information on a variety by enhancing the structures on its derived category or its abstraction, the triangulated category.

Another field of interest is groups or group actions. Groups were originally a language for describing symmetries behind solutions of equations, but nowadays, they are an indispensable tool not only in mathematics but also in many areas of physics such as crystallography or gauge theory. Often, groups are studied through their representation theory. K. Saito considers sets of vanishing cycles coming from geometry as a generalization of root systems, and applies the corresponding theory of infinite dimensional Lie algebras and its representations to geometry. In T. Kobayashi's new theory of global analysis for minimal representation and visible action on complex varieties, which are his recent themes, groups appear as "leit motiv", and the theory is expanded in a way special cases are connected to infinite dimensional representation theory. A. Tsuchiya studies the algebraic structures of logarithmic conformal field theory such as the representation theory of the chiral algebra and conformal blocks. T. Kohno studies monodromy representations of braid groups appearing in conformal field theory from the point of view of hypergeometric integrals.

Some researchers at the Kavli IPMU also study equations, one of the original goals of algebra. One of the ultimate goals of modern arithmetic is a framework called the Langlands program, which predicts that two seemingly completely different looking sets of representations coming from arithmetic coincide in a natural sense. This vast conjecture includes even Fermat's last theorem as a very small part. It is therefore not surprising that this program is thought to be very difficult to realize, however a number of simpler variants exist. S. Kondo and T. Abe are working on the local Langlands program and the Langlands program for function fields for example. Yet another variant of the Langlands program, for which a connection to S-duality in physics has been observed, is the geometric Langlands program. The Langlands program and its variants have therefore become very active and important modern topics of research.

As one can see, the Mathematics Group study many branches of algebra here at the Kavli IPMU. Algebra may not necessarily directly deal with understanding the universe and moreover most of the algebraists at the Kavli IPMU are interested in mathematics in and of itself, not in its application to other fields. However, when the efforts of practitioners of different disciplines align, the benefit to all fields involved is huge. The daily efforts of the Mathematics Group in understanding the structures ubiquitous to mathematics feed directly into efforts directed at understanding the most fundamental phenomena of nature. The Mathematics Group therefore await the next great breakthrough rivaling Galois' discovery of groups.

5.10 Models beyond the Standard Model

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Charles Steinhardt
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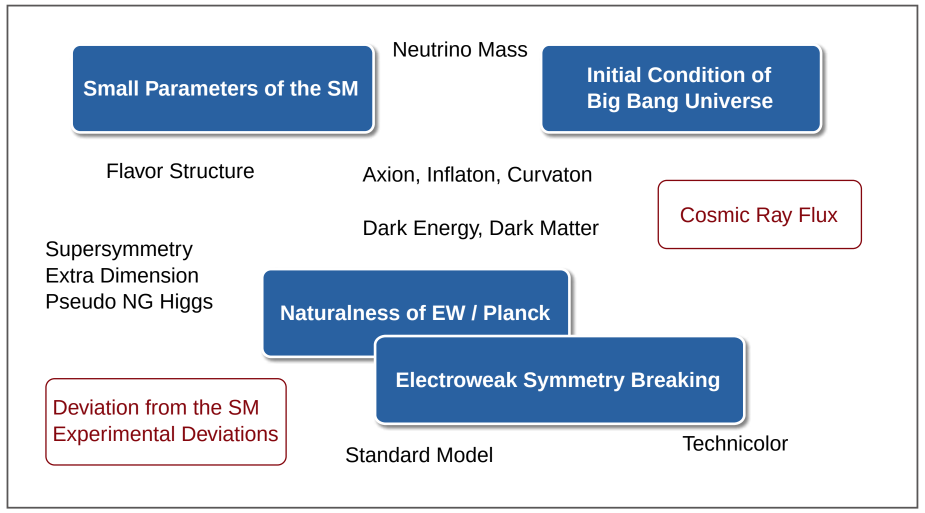

Up to now, we have seen that a quantum field theory with quarks, leptons and vector bosons for three different forces describes reasonably well all the experimental data available so far. Among the vector bosons, however, those corresponding to the weak force (which is responsible for the β-decay of nucleons) are known to have masses. There are three such vector bosons, and they are called W^+, W^- and Z bosons, or weak bosons, as a whole. From the consistency of quantum field theories, it is known that something must be behind the non-zero masses of these vector bosons.

What is called the Standard Model provides a simple theoretical idea how the weak bosons acquire masses. According to the Standard Model, the masses originate from condensation of quanta of a new scalar boson, called Higgs boson. The Higgs boson was the last missing piece of the Standard Model, and was discovered in LHC experiments in this year. The observed mass about 125 GeV is consistent with the mechanism predicted by the Standard Model. This mass is also consistent with our prediction in supersymmetric standard model with relatively large SUSY breaking at 10 – 100 TeV.

Is that the end of the story? Maybe ..., but maybe not. Let us think about the following questions.

- The Higgs boson is the only scalar field in the Standard Model; all other dynamical degrees of freedom in the Standard Model are either fermions or vector fields. Why does the Standard Model have one scalar field, and just one? Why does its condensation develop?
- The Newton constant $G_N \simeq 6.7 \times 10^{-11}$ m^{3}kg/s^2 corresponds to an energy scale $1/\sqrt{G_N \hbar /c^3} \sim 10^{19}$ GeV. Why is there a huge hierarchy of order 10^{17} between this energy scale and theweak boson masses of order 10^2 GeV, and how can the weak boson masses remain so small under quantum corrections?

In order to solve these questions theoretically, various models beyond the Standard Model have been constructed so far, and we still continue to do so in quest of a better solution to these problems. Once we have concrete models, we can examine whether such models are really consistent with all the available experimental data, predict what kind of signals can be expected in future experiments, and even propose experiments to confirm such models.

The origin of the masses of the weak bosons is not the only puzzle of the Standard Model. It is known that huge fraction of the universe consists of dark matter and dark energy. It is very unlikely that dark matter is actually the ordinary matter particles in the Standard Model. This is where we find another motivation to extend the Standard Model. Our universe may have become so large because of an inflationary process in the early universe, and quantum fluctuations of a scalar field may become the fluctuations of density in the early universe, which eventually become galaxies and clusters of galaxies. So, here is another motivation to introduce a new degree of freedom and extend the Standard Model. Such cosmological issues as inflation, primordial density perturbations, and dark matter motivate extensions of the Standard Model, and models in quantum field theories are the appropriate framework in order to work on these issues.

Recent reports of excess in high-energy cosmic ray fluxes, deviation from the Standard Model prediction of the anomalous magnetic moment of muon, and some other reports of deviations from the Standard Model predictions may also be indications of some physics beyond the Standard Model. The Models beyond the Standard Model Group therefore seek for theoretical models that account for these phenomena.

This Group also address the following problems. The Standard Model is described by a quantum field theory with about 30 parameters, and the values of these parameters can be determined only by measuring them experimentally. Would it be possible to determine them theoretically, by considering theoretical frameworks that contain the Standard Model?

The thermal history of early universe is described very well by the Standard Model at least back to the era with the temperature of order MeV, but it is only with several input parameter values of the initial condition of the universe. Those initial condition parameters include baryon asymmetry, normalization of density contrast, and the amount of dark energy. How are these initial condition parameters set? Once again, it is impossible to think about such problems without a model that extends the Standard Model.

For non-experts

After k_B, c and $\hbar$ are set to unity, [length] = [energy]$^{-1}$ is the only dimension left in physics. The fundamental law of physics in nature has been probed down to the length scale of order 10^{-3} fm = 10^{-8} Å, which is equivalent to the energy scale of order 10^2 GeV = 10^{11} eV. Nothing is known for sure yet, however, on what is happening at even shorter distance scales.

5.11 Neutrino Physics

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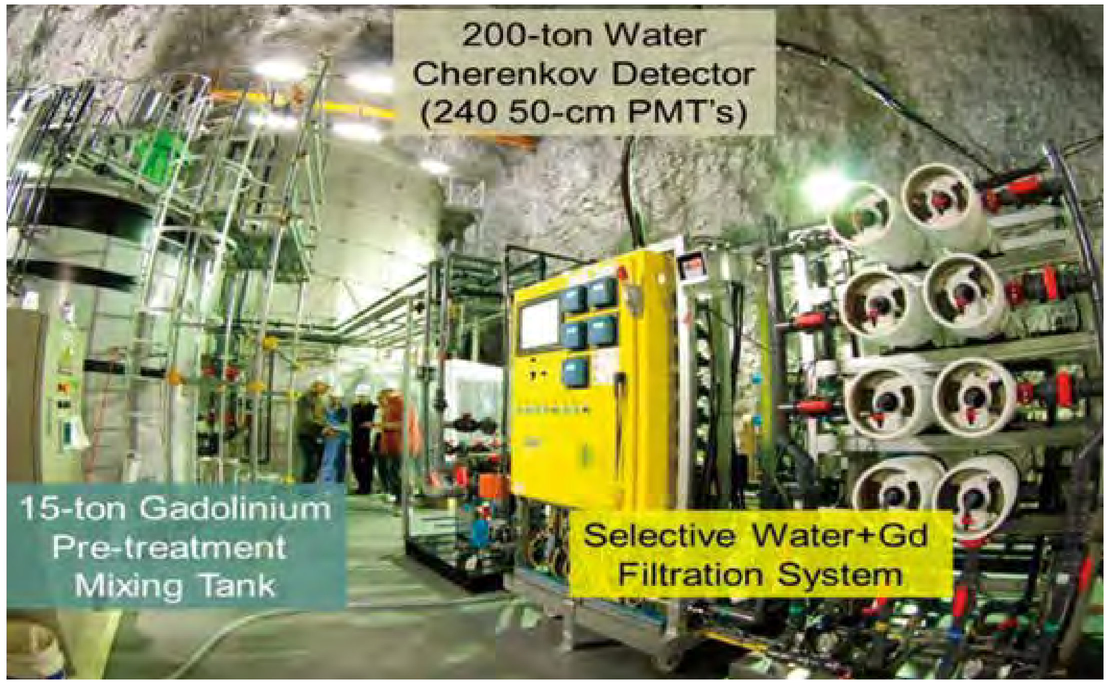
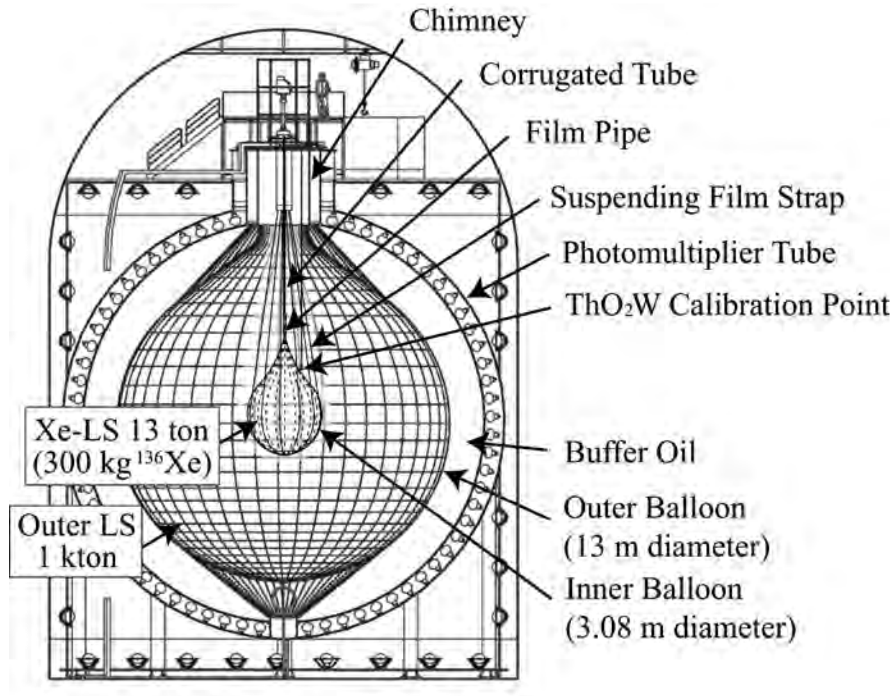


What are the building blocks of nature? Most people have heard of electrons, which are indeed (as far as we can tell) fundamental particles, as well as protons and neutrons, which are themselves composite objects composed of much smaller fundamental particles called quarks. But there are much more unusual fundamental particles, too, and perhaps the most mysterious of these are the neutrinos.

The Standard Model of particle physics contains three generations of fundamental particles. In each of these generations, or families, there are two quarks and two much less massive particles called leptons. In the first family one such lepton is the electron, which carries an electric charge, and the other first-generation lepton is called the electron neutrino, which is electrically neutral. The second generation contains two more types of quarks, a charged lepton called the muon, and the muon neutrino, while the third family contains a final pair of quarks, a charged lepton called the tau, and a tau neutrino.

The three types of neutrinos, the electron neutrino, the muon neutrino, and the tau neutrino, are exceedingly challenging to study, because they hardly interact with matter at all. That means neutrino detectors need to be very big, very sensitive, or both. At the Kavli IPMU there are teams of researchers working on some of the best and most famous neutrino detectors in the world.



The Super-Kamiokande [Super-K] detector is a 50,000 ton tank of water buried deep under the Japanese Alps. By studying neutrinos generated by cosmic ray interactions in the Earth's atmosphere, in 1998 Super-K made the stunning discovery that different types of neutrinos can spontaneously transform from one type to another, a process known as neutrino oscillation. This also implied that at least two of the three neutrinos have a small, but non-zero mass, something not predicted by the Standard Model. This was the first time since its inception that the Standard Model needed to be revised based on solid experimental data. In 2001 Super-K made a crucial contribution to the solution of the solar neutrino problem by indicating that solar neutrinos produced by the Boron-8 reaction in the Sun could change their flavor while in flight, and uniquely selected the large mixing angle solution to the problem. the Kavli IPMU members are now working on GADZOOKS!, an initiative to enrich the ultra-pure water inside Super-Kamiokande with the element gadolinium. This will greatly reduce backgrounds and, among many other physics benefits, should allow the first-ever detection of a constant stream of neutrinos from distant supernovas.

The KamLAND neutrino detector is located in the same ancient zinc mine as Super-Kamiokande, but instead of water it is filled with 1,000 tons of liquid scintillator. This makes it very sensitive, especially to low energy neutrinos from nuclear reactors and those generated by radioactive decays within the Earth itself. In 2002 KamLAND was the first experiment to observe disappearance of reactor neutrinos, which matched other experiments' solar neutrino data in spectacular fashion. After lowering the energy threshold at which their data could be analyzed, in 2005 KamLAND was the first experiment to detect Geo-neutrinos, ushering in an entirely new way to study the Earth's interior. Also in 2005, KamLAND saw evidence of spectral distortions in the reactor neutrino signal; clear proof of neutrino oscillations.

Whether neutrino is a Majorana particle or not (i.e., if neutrino coincides with its anti-particle or not) is critical for understanding the mechanism that created a small excess of matter in the early universe, leading to the matter-dominated present-day universe. If neutrino is the Majorana particle, the double beta-decay, which ordinarily emits two neutrinos or two anti-neutrinos, can proceed without neutrino or anti-neutrino emission. This process is called neutrinoless double beta-decay. The Kavli IPMU members are focusing on KamLAND-Zen project aimed at detection of neutrinoless double beta-decay of Xenon-136 using KamLAND. The first batch of data accumulated in 2011-2012 produced the most precise measurement of ordinary double beta-decay half-life and the most stringent limit on the neutrinoless double beta-decay (including the most stringent limit on the Majoron coupling to the neutrino).

As we continue to understand the mysterious neutrinos, as well as the varied processes which produce them within the Earth, upon the Earth, above the Earth, within the Sun, and inside exploding stars, the Kavli IPMU researchers are using these tiniest of particles to probe the most inaccessible places and farthest reaches of the universe itself.

5.12 Observational Cosmology

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Takaya Nozawa
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Hajime Sugai
Naoshi Sugiyama
Masahiro Takada
Masayuki Tanaka
Atsushi Taruya
Nozomu Tominaga
Edwin Turner
Benedetta Vulcani
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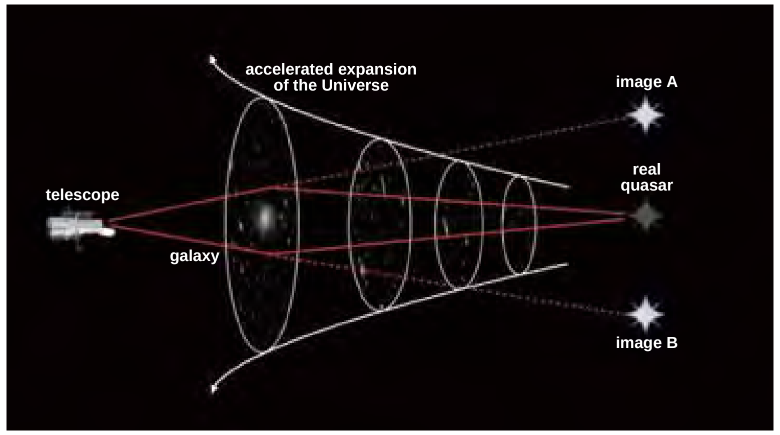

Understanding the nature and origin of large-scale structure in the Universe is one of the most compelling issues in observational cosmology. The currently most conventional scenario is given by the cold dark matter (CDM) dominated model, where gravitational instability mainly driven by spatial inhomogeneities of CDM distribution amplifies the seed density perturbations to form the present-day hierarchical structures. Therefore revealing distribution and amount of CDM is crucial to understanding the formation of large-scale structure. In addition the presence of dark energy drives the accelerating cosmic expansion, and therefore affects the growth of structure formation. The dark matter distribution and the nature of dark energy can be explored from massive galaxy surveys.
The Observational Cosmology Group have been actively working both on the measurements using currently available telescope facilities and on the planning of future instruments. The two powerful investigative tools are the gravitational lensing effect and the baryon acoustic oscillation.

Gravitational lensing effect:
The path of light ray emitted by a distant galaxy is bent by gravitational force of intervening large-scale structure during the propagation, causing the image to be distorted – the so-called weak lensing shear. Conversely, measuring the coherent shear signals between galaxy images allows us to reconstruct the distribution of invisible dark matter. Moreover, since the weak lensing shear deals with the light propagation on cosmological distance scales, the lensing strengths depend on the cosmic expansion history that is sensitive to the nature of dark energy. Thus weak lensing based observables offer a powerful way for studying the nature of invisible components, dark matter and dark energy. The Observational Cosmology Group are carrying out observational and theoretical studies of weak lensing phenomena using their own Subaru data sets as well as simulations of large-scale structure.

Baryon acoustic oscillation:
To measure properties of dark energy, one needs to measure the expansion history of the Universe precisely. Because light travels at a finite speed, one can measure the expansion rate of the past by looking far. Comparing the expansion rate at varying distances would reveal the expansion history. The expansion itself is relatively easy to measure. The light emitted by a distant galaxy is stretched by the expansion of space and becomes redder, which can be measured by any decent spectrograph.

To measure the expansion history, however, one also needs to know how far back in time the light was emitted from the galaxy, or equivalently, how far away it is. Measuring precise distances in cosmological scales is very challenging. Clustering of baryonic matter at a certain characteristic scale that is imprinted by baryon acoustic oscillation (BAO), or propagation of acoustic waves, in the early universe serves as a "standard ruler" for cosmological observations. This technique requires to study millions of galaxies in a wide field of view, and map the spatial distribution of luminous galaxies to detect the characteristic scale.

Hyper-Suprime Cam (HSC):
The HSC is the project to replace the prime focus camera of Subaru Telescope (8.2 meter optical-infrared telescope at the summit of 4,200 m high Mauna Kea, Hawaii) with a new camera that has wider field-of-view than the previous one by a factor of 10. Fully utilizing the unique capabilities of HSC, its survey speed and excellent image quality, a massive galaxy survey will be conducted covering an area of a few thousands square degrees and reaching to the depth to probe the Universe up to redshifts of a few. In fact these data sets will provide an ideal data sets for exploring the nature of dark matter and dark energy via measurements of cosmological observables available from the data, weak lensing and galaxy clustering statistics. The Kavli IPMU members are actively involved in this HSC project, and working on the designing and planning of HSC galaxy survey and development of data analysis pipeline.

Sloan Digital Sky Survey III:
In January 2011, the SDSS-III collaboration released the largest digital color image of the sky ever made. The image has been put together over the last decade from millions of 2.8-megapixel images taken at the 2.5-meter telescope at the Apache Point Observatory in New Mexico, thus creating a color image of more than a trillion pixels. This new SDSS-III data release, along with the previous SDSS-I and SDSS-II data releases that it builds upon, gives astronomers the most comprehensive view of the night sky ever made. SDSS data have already been used to discover nearly half a billion astronomical objects, including asteroids, stars, galaxies and distant quasars.

The Kavli IPMU has been a part of the SDSS-III and involved in the study of these rich images. But the focus of the Observational Cosmology Group has been to conduct a new survey to a deeper universe with the improved spectrograph. This survey, the Baryon Oscillation Spectroscopic Survey (BOSS), maps the spatial distribution of luminous galaxies and quasars to detect the characteristic scale imprinted by baryon acoustic oscillations in the early universe. Using the acoustic scale as a standard ruler, the angular diameter distance to the galaxy redshift can be inferred. The BOSS has started to take data in 2009 and will continue until 2014. Its goal is to precisely measure how Dark Energy has changed over the recent history of the Universe.

Prime Focus Spectrograph (PFS):
The PFS project that mounts a next generation spectrograph on the Subaru telescope and is planned to start data taking later this decade was overwelmingly endorsed at the Subaru Users meeting of January 2011. Using a wide angle view of Subaru telescope and the PFS, several thousand galaxies can be studied at the same time and the baryon acoustic oscillation technique can be used.

In addition to BAO, there are a number of other measurements to constrain the properties of dark energy using this instrument. Furthermore, this type of spectrograph with a large field of view and a massive multi-object capability will be unique among the largest telescopes in the world, allowing for unprecedented studies of formation and evolution of galaxies, as well as the assembly history of our own Milky Way Galaxy.

The strength of this project comes from exploiting the data using the HSC. The combination of imaging using HSC and spectroscopy using PFS is dubbed SuMIRe, Subaru Measurement of Images and Redshifts. The SuMIRe project is expected to repeat and exceed the tremendous success of Sloan Digital Sky Survey (SDSS), but with a much deeper view of the Universe back to the era that formed early stars and supermassive blackholes.

5.13 | Proton Decay

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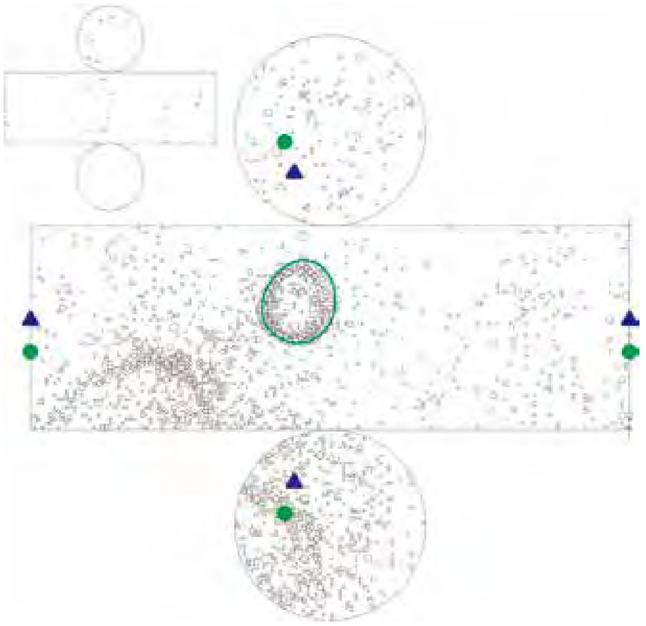

Monte Carlo event for a proton decaying into a muon and a neutral kaon. Credit: ICRR

The stability of the proton represents one of the greatest theoretical and experimental challenges in particle physics today. In most grand unified theories, particularly those with a TeV intermediate mass scale, the proton "wants" to decay. Experimentally, however, the proton seems determined to outlive us all. Beginning with the first large-scale searches in the 1980's, one promising theory after another has floundered on the shoals of nucleon decay. To date, no hint of a nucleon decay signal has emerged.

In spite of this, the study of nucleon decay provides one of the few approaches to the problem of confronting grand unified theories with experimental data, and any progress toward this goal has unique value for the future development of physics. This program has already been a success. The simplest unification model, minimal SU(5), has been ruled out by the experimental results. Every subsequent grand unification theory will remain only a mathematical construct if further experimental information is not available.

The search for nucleon decay requires massive detectors. A search with a sensitivity of 10^{33} years, for example, requires a detector with approximately 10^{33} nucleons. Since there are 6×10^{29} nucleons per ton of material, this implies detectors of multi-kiloton scale.

The "classical" proton decay mode, $p \rightarrow e^{+}\pi^{0}$, can be efficiently detected with low background. At present, the best limit on this mode ($\tau / \beta > 1.21 \times 10^{34}$ yr, 90% CL, is the decay mode branching ratio) comes from a 206 kton·yr exposure of Super-Kamiokande. The detection efficiency of 45% is dominated by final-state π^{0} absorption or charge-exchange in the nucleus, and the expected background is 2 events/Mton·yr.

Supersymmetric theories favor the mode $p \rightarrow \nu K^{+}$, which is experimentally more difficult due to the unobservable neutrino. The present limit from Super-Kamiokande is the result of combining several channels, the most sensitive of which is $K^{+} \rightarrow \mu^{+} \nu$ accompanied by a de-excitation signature from the remnant ^{15}N nucleus. Monte Carlo studies suggest that this mode should remain background free for the foreseeable future. The present combined limit is $\tau / \beta > 3.3 \times 10^{33}$ yr (90% CL).

Recent theoretical work suggests that if super-symmetric SO(10) provides the framework for grand-unification, the proton lifetime (into the favored νK^{+} decay mode) must lie within about one order of magnitude of present limits. Similarly, SO(10) theories suggest $\tau / \beta\ (e^{+} \pi^{0}) \approx 10^{35}$ years – about a factor of ten beyond the present limit. Thus, continued progress in the search for nucleon decay inevitably requires larger detectors.

Moreover, the enormous mass and exposure required to improve significantly on existing limits (and the unknowable prospects for positive detection) underline the importance of any future experiment's ability to address other important physics questions while waiting for the proton to decay. Proton decay experiments have made fundamental contributions to neutrino physics and particle astrophysics in the past, and any future experiment must be prepared to do the same.

5.14 | String Theory

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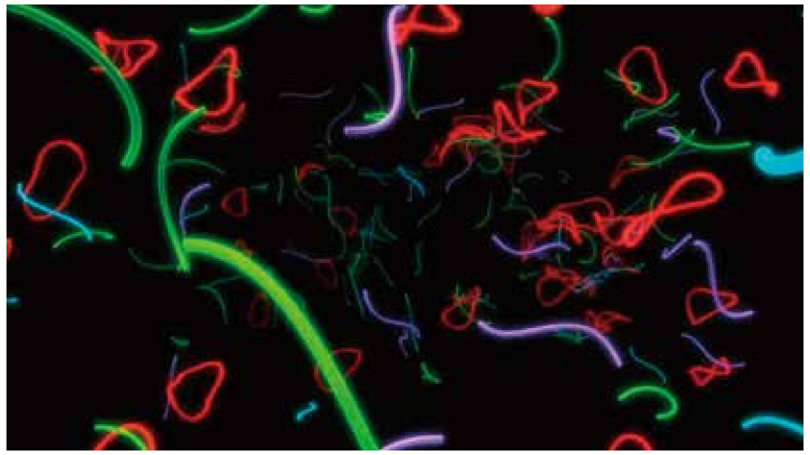

In the past few hundred years, scientists have searched for fundamental laws of nature by exploring phenomena at shorter and shorter distances. Does this progression continue indefinitely? Surprisingly, there are reasons to think that the hierarchical structure of nature will terminate at 10^{-35} meter, the so-called Planck length. Let us perform a thought-experiment to explain why this might be the case. Physicists build particle colliders to probe short distances. The more energy we use to collide particles, the shorter distances we can explore. This has been the case so far. One may then ask: can we build a collider with energy so high that it can probe distances shorter than the Planck length? The answer is no. When we collide particles with such high energy, a black hole will form and its event horizon will conceal the entire interaction area. Stated in another way, the measurement at this energy would perturb the geometry so much that the fabric of space and time would be torn apart. This would prevent physicists from ever seeing what is happening at distances shorter than the Planck length. This is a new kind of uncertainty principle. The Planck length is truly fundamental since it is the distance where the hierarchical structure of nature will terminate.

Space and time do not exist beyond the Planck scale, and they should emerge from a more fundamental structure. Superstring theory is a leading candidate for a mathematical framework to describe physics at the Planck scale since it contains all the ingredients necessary to unify general relativity and quantum mechanics and to deduce the Standard Model of particle physics. Superstring theory has helped us solve various mysteries of quantum gravity such as the information paradox of black holes posed by Stephen Hawking. The theory has given us insights into early universe cosmology and models beyond the Standard Model of particle physics. It provides powerful tools to study many difficult problems in theoretical physics – often involving strongly interacting systems – such as QCD (theory of quark interactions), quantum liquid and quantum phase transitions. It has also inspired many important developments in mathematics. All of these aspects of string theory are vigorously investigated at the Kavli IPMU.

5.15 Structure Formation

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Ayuki Kamada
Chiaki Kobayashi
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Atsushi Nishizawa
Ken'ichi Nomoto
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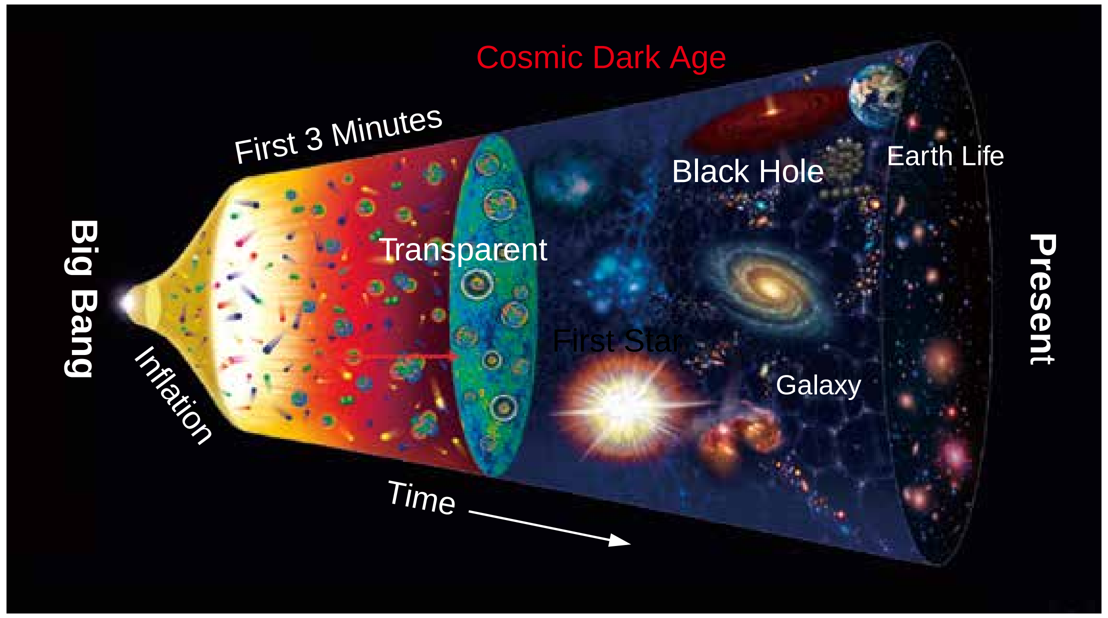
Masami Ouchi
Tomoki Saito
Malte Schramm
John Silverman
Charles Steinhardt
Masahiro Takada
Masayuki Tanaka
Atsushi Taruya
Edwin Turner
Naoki Yoshida



Adapted from "Physics of the history of the universe" by Yasuo Fukui et al.

There are rich structures in the present-day universe, such as stars, galaxies, and large scale structure. The Structure Formation Group study how these objects are formed using large computer simulations and sophisticated theoretical models.

The standard Big Bang model posits that the universe was nearly homogeneous and very hot when it was born. Tiny "ripples" in the distribution of matter were generated through a rapid expansion phase called inflation in the very early universe. These primeval density fluctuations grew by the action of gravity, eventually forming luminous objects such as galaxies.

The energy content of the universe and basic statistic that describe the condition of the early universe have been determined with great accuracy from recent observations of cosmic microwave background radiation, large-scale galaxy distribution and distant supernovae. Cosmology is now at a stage where theory can make solid predictions, whereas a broad class of observations can be directly used to verify them. The ongoing large-scale galaxy survey, the Sloan Digital Sky Survey III, and the planned Hyper Suprime-Cam Survey will provide rich information on the nature of dark matter and dark energy. Accurate theoretical predictions are needed to make the full use of the observational data.

The primary interests of the Structure Formation Group are in primordial star formation in the early universe, the formation and evolution of galaxies, and the formation of large-scale structure. Results from these studies are used for making plans for Subaru-HSC/PFS dark energy survey.

5.16 Supernova

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Alexander Kusenko
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Keiichi Maeda
Kai Martens
Anupreeta More
Surhud More
Takashi Moriya
Ken'ichi Nomoto
Takaya Nozawa
Christian Ott
Robert Quimby
Kate Scholberg
Henry Sobel
James Stone
Yoichiro Suzuki
Yasuo Takeuchi
Nozomu Tominaga
Mark Vagins
Naoki Yasuda
Naoki Yoshida

M51 Galaxy before (left) and after (right) the eruption of SN 2011dh. The image on the left was taken in 2009, and on the right on July 8th, 2011. See Section 6.3 for details. Credit: Conrad Jung.

Supernovae are explosions of stars at the end of their lives. Core-collapse supernovae (Type II, Ib, and Ic) are the outcome of the gravitational collapse of massive stars (i.e., more than eight times as massive as the Sun), followed by formation of a neutron star or a black hole, announced by a huge amount of neutrinos and probably gravitational wave. Thermonuclear supernovae (Type Ia) are explosions driven by nuclear reactions within a white-dwarf star.

Supernovae provide natural laboratories for a range of physical processes, such as neutrino and strong gravitation physics, many of which cannot be addressed by experiments on the Earth. Furthermore, they are the main contributors of heavy elements in the Universe; without them, baryons in the Universe would be only hydrogen, helium and some minor elements, although in reality the Universe is filled with about a hundred different sorts of elements. Their energy produced at the explosions is huge, and supernova explosions could play important roles even in formation and evolution of galaxies. They are among the brightest objects in the Universe, highlighted by recently discovered super-luminous supernovae, and as such they can be used as a beacon to probe the high redshift Universe. Finally, importance of understanding their natures is highlighted by their use as cosmological distance indicators, leading to the discovery of the Dark Energy.

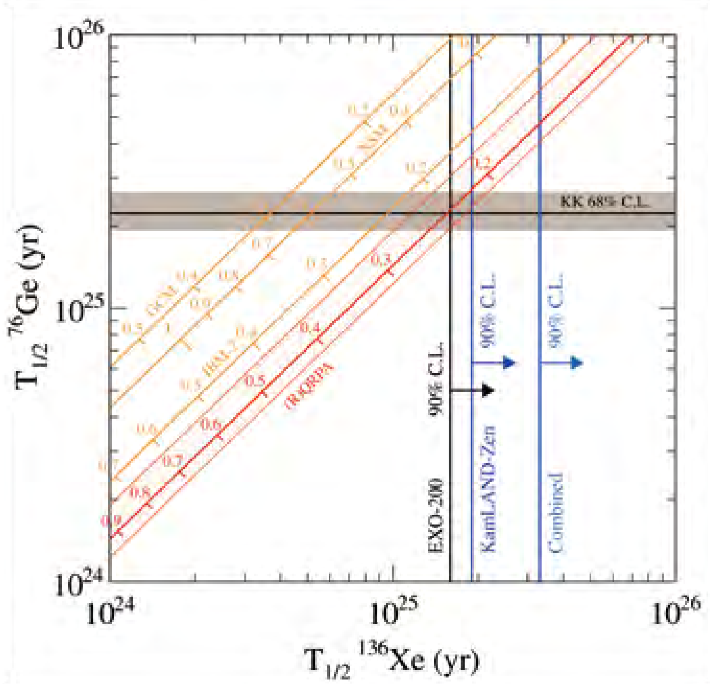
Our understanding of the above issues is still far from satisfying, with various issues still under investigation. At the Kavli IPMU, a wide range of topics related to supernovae both in theory and observation/experiment are covered; Evolution of stars toward supernovae, theory of explosions, attempt to detect these neutrinos at Kamioka, nucleosynthesis of elements up to iron and beyond, formation of dust grains, theory of optical emission from supernovae and evaluation of their use as cosmological distance indicators, and observations using the Subaru telescope including future large survey planning with the HSC. By unifying these attempts, The Supernova Group aim to comprehensively understand supernovae and their influences on the evolution of the Universe.

6 Research Highlights

6.1 Results from the First Phase of KamLAND-Zen

Double-beta ($\beta\beta$) decay, in which two neutrons are simultaneously transformed into two protons, occurs rarely in even-even nuclei, for which ordinary beta decay is energetically forbidden or highly suppressed. It is a second-order weak interaction process emitting two electron anti-neutrinos and two electrons and therefore denoted by $2\nu\beta\beta$.

The experimental search for $2\nu\beta\beta$ had been pursued over the past decades by small research groups with very limited resources. This situation has changed dramatically since the discovery of a non-zero neutrino mass in a number of neutrino oscillation experiments, and today the search for $\beta\beta$ decay is conducted by several large-scale $\beta\beta$ experiments using different techniques. Experimental observation of $2\nu\beta\beta$ decay has now become reality, and main efforts have been shifting towards the search for hypothetical $\beta\beta$ decay modes forbidden in the Standard Model.



Experimental results on $0\nu\beta\beta$ decay half-life ($T^{0\nu}_{1/2}$) in ^{76}Ge and ^{136}Xe. The 68% C.L. limit from the ^{76}Ge claim is shown as a horizontal gray band. The limits of both KamLAND-Zen and EXO-200, and their combined result are shown at 90% C.L. The correlation between the ^{76}Ge and ^{136}Xe half- lives predicted by various NME calculations is drawn as diagonal lines together with the $\langle m_{\beta\beta}\rangle$(eV) scale.

If neutrinos are massive Majorana particles, $\beta\beta$ decay might occur without emission of any neutrinos ($0\nu\beta\beta$ decay). Observation of such a process would demonstrate that the lepton number is not conserved in nature. Moreover, if the process is mediated by an exchange of a light left-handed neutrino, its rate increases with the square of the effective Majorana neutrino mass $\langle m_{\beta\beta}\rangle \equiv |\Sigma_i U_{ei}^2 m_{\nu i}|$, and hence its measurement would provide information on the absolute neutrino mass scale. To date, only one observation of $0\nu\beta\beta$ decay in ^{76}Ge has been claimed. (Mod. Phys. Lett. A **21**, 1547 (2006)).

The KamLAND-Zen (KamLAND Zero-Neutrino Double-Beta Decay) experiment is one of the latest projects aimed at the $0\nu\beta\beta$ decay search. It consists of 13 tons of Xe-loaded liquid scintillator contained in a 3.08-m-diameter transparent nylon-based inner balloon (IB), suspended at the center of the KamLAND detector by film straps. The IB is surrounded by 1 kton of liquid scintillator contained in a 13-m-diameter outer balloon. To detect scintillation light, 1,325 17-inch and 554 20-inch photomultiplier tubes are mounted on the stainless-steel containment tank, providing 34% photo-cathode coverage. This tank is surrounded by a 3.2-kton water-Cherenkov detector for cosmic-ray muon identification.

KamLAND-Zen released its first $0\nu\beta\beta$ half-life limit, $T^{0\nu}_{1/2} > 5.7 \times 10^{24}$ yr at 90% C.L., based on a 27.4 kg·yr exposure (Phys. Rev. C **85**, 045504 (2012)). Although the sensitivity of this result was affected by the presence of an unexpected background peak just above the 2.458 MeV Q-value of ^{136}Xe $\beta\beta$ decay, the Majorana neutrino mass sensitivity was similar to that in the ^{76}Ge claim. Soon after this KamLAND-Zen's release, EXO-200, another Xenon-based experiment, also published a factor of 2.8 more stringent limit, constraining the result in ^{76}Ge for a number of nuclear matrix element (NME) calculations.

In the latest publication of KamLAND-Zen Collaboration (Phys. Rev. Lett. **110**, 062502 (2013)) $T^{0\nu}_{1/2} > 1.9 \times 10^{25}$ yr at 90% C.L was reported as the most strict up-to-date limit for the neutrinoless $\beta\beta$ decay half-life from the first phase of the KamLAND-Zen experiment, corresponding to an exposure of 89.5 kg·yr of ^{136}Xe. A combination of the results from KamLAND-Zen and EXO-200 has yielded $T^{0\nu}_{1/2} > 3.4 \times 10^{25}$ yr (90% C.L.).

The KamLAND-Zen Collaboration has converted this combined half-life limit to a 90% C.L. upper limit of $\langle m_{\beta\beta}\rangle < (120 - 250)$ meV using NME calculations. The constraint from this result on the detection claim is shown in the figure for different NME estimates. The combined result for ^{136}Xe refutes the $0\nu\beta\beta$ detection claim in ^{76}Ge at > 97.5% C.L. for all NMEs considered assuming that $0\nu\beta\beta$ decay proceeds via light Majorana neutrino exchange.

The KamLAND-Zen result is still limited by the unexpected background caused by ^{110m}Ag (β-decay, τ = 360 days, Q = 3.01 MeV) which may originate from either Fukushima-I fallout or cosmogenic productions by Xenon spallation. In order to remove ^{110m}Ag, KamLAND-Zen Collaboration is going to distill the liquid scintillator and pursue other options such as IB replacement and further upgrades on the detector.

6.2 Unified Description of Nambu-Goldstone Bosons without Lorentz Invariance

Spontaneous Symmetry Breaking is a very universal concept applicable for a wide range of systems: crystal, superfluid, neutron stars, Higgs boson, magnets, even why there are more right-handed people with hearts on the left-hand side and many others. In particular, continuous symmetries produce gapless Nambu-Goldstone bosons that govern the phenomena at long wavelengths and small energies. Yet there is a variety in the spectra of gapless excitations even when the symmetry breaking patterns are the same. The original Nambu theory proposed in 1961 was constructed in the framework of a quantum field theory for elementary particles, assuming their interactions in vacuum at the absolute zero temperature, and hence Lorentz-invariance. Therefore, this theory cannot be directly applied to the Lorentz-non-invariant cases with finite temperature and density. Then truly basic questions, such as the number of Nambu-Goldstone bosons or their dispersion relations, had been studied only on case-by-case basis without a general framework. Kavli IPMU Director Hitoshi Murayama and his collaborator Haruki Watanabe recently proposed a framework to understand Nambu-Goldstone bosons in a unified way by representing all known examples in a single-line Lagrangian of the low-energy effective theory, thus extending the celebrated Nambu-Goldstone theorem to Lorentz-non-invariant systems (Phys. Rev. Lett. **108**, 251602 (2012), chosen for Editor's Suggestion and Physics Sypnosis).

In Lorentz-invariant systems, the number of Nambu-Goldstone bosons n_{NGB} is always equal to the number of broken symmetry generators n_{BG}. All of them have the identical linear dispersion $\omega = c|k|$. However, once the Lorentz invariance is discarded, the situation varies from one system to another. Murayama and Watanabe proved a general theorem that relates n_{NGB} and n_{BG}. It is shown that the number of Nambu-Goldstone bosons n_{NGB} is less than the number of broken generators n_{BG} when some of them form canonically conjugate pairs. The pairing occurs when the generators have a nonzero expectation value of their commutator. This result applies to all dynamical systems subject to spontaneous symmetry breaking, under the assumption made, namely, there are no gapless excitations other than Nambu-Goldstone bosons. In particular, it is the first result showing the implications of spontaneous symmetry breaking on the low energy spectrum in general, and is applicable to non-relativistic systems of interest in condensed-matter physics.

There is a clear geometrical picture behind this framework. The spontaneous symmetry breaking is always characterized by a homogeneous space G/H. In Lorentz-invariant systems to the leading order in energy and momenta, all that needs to be specified is G-invariant metric on G/H. Once Lorentz invariance is dropped, one also needs to specify a *presymplectic structure* on G/H, namely G-invariant closed two-form, which corresponds to the expectation value of the commutators among the generators. In all physically relevant cases, G/H has a projection π down to a symplectic homogeneous space B, whose symplectic structure ω is pulled back to G/H as $\pi^*\omega$. The $2n_B$ generators on B form canonically conjugate pairs, giving rise to n_B Nambu-Goldstone bosons of Type-B. The remaining generators on the fiber are not paired, corresponding to n_A Nambu-Goldstone bosons of Type-A. The total number of broken generators are $n_{BG} = n_A + 2n_B$, while the total number of Nambu-Goldstone bosons is $n_{NGB} = n_A + n_B \leq n_{BG}$. Generically Type-A NGBs have linear dispersions $\omega \propto |k|$, while Type-B quadratic dispersions $\omega \propto |k|^2$. The authors verified these universal results in a vast number of examples in the literature. Future studies include extra "light" degrees of freedom beyond the Nambu-Goldstone bosons, spacetime symmetries, *pseudo*-Nambu-Goldstone bosons when some symmetries are explicitly broken, and quantum numbers of topological defects.

Example	G/H	n_{BG} – n_{NGB} = (1/2) rank ρ		
QCD	SU(3) ×SU(3)/SU (3)	8	8	0
Antiferromagnetism	SO(3)/SO(2)	2	2	0
Ferromagnetism	SO(3)/SO(2)	2	1	1
Ferrimagnetism	SO(3)/SO(2)	2	1	1
Kaon (μ=0)	U(2)/U(1)	3	3	0
Kaon (μ>0)	U(2)/U(1)	3	2	1
BEC (planar)	SO(3) × U(1)/U(1)	3	3	0
BEC (ferro)	SO(3) × U(1)/U(1)	3	2	1
Crystal (2+1D)	T^2	2	2	0
Wigner Crystal	T^2	2	1	1
Skyrmion Lattice	T^2	2	1	1

In this table, "Kaon" means a model describing kaon condensation. It was discussed by T. Schäfer et al. [Phys. Lett. B **522**, 67 (2001)]. To deal with finite density, this model introduces the chemical potential μ, and Lorentz invariance is explicitly violated. "BEC" means *F*=1 spinor Bose-Einstein condensate. There are ferromagnetic BEC and planar BEC. The "Wigner Crystal" listed here corresponds the case in which there is a magnetic field along the z direction.

6.3 A Yellow Supergiant Star Was Found to Be a Progenitor of a Type Ⅱb Supernova

A group of researchers including Melina Bersten, Ken'ichi Nomoto, Gaston Folatelli and Keiichi Maeda of Kavli IPMU) presented evidence that a yellow supergiant (YSG) star found at the location of supernova SN 2011dh in the famous nearby galaxy M51 was indeed the star that exploded. The study of YSG progenitors had been controversial because they could not easily fit the theory of stellar evolution. However, a confirmation on this topic came in March 2013 with an announcement of the disappearance of a YSG star in images collected by the Hubble Space Telescope (HST) while the SN faded enough. Bersten and collaborators have already predicted that the explosion should leave behind a very blue star that was the binary companion of exploded YSG. Their efforts now aim at confirming the proposed model by detecting the blue companion in future HST observations.

The nature and diversity of progenitor stars or progenitor systems of core-collapse supernovae are important open questions in the field of astrophysics. It is believed that most massive stars explode when they become red supergiants, or, alternatively, blue compact stars (so-called Wolf-Rayet stars). Recent detections of YSG stars as possible progenitors of supernovae have posed serious questions on our understanding of the evolution of massive stars.

Due to its proximity, SN 2011dh in M51 was one of the brightest and best studied supernovae of 2011 (See figure on page 37). It was classified as a type IIb supernova, that is, it showed hydrogen lines in its initial spectrum which later evolved into a helium-dominated spectrum. This is indicative of a progenitor star that has lost most of its hydrogen-rich envelope prior to the explosion.

By searching through archival images taken by the Hubble Space Telescope before the supernova explosion, two groups of astronomers independently detected a source at a location closely matching that of the supernova. Photometry of this pre-supernova source was compatible with a YSG star. The question then arose as to how such a star could undergo a supernova explosion. Stellar evolutionary models predict that stars, which become massive enough to produce a supernova explosion by core collapse, should end their lives as red supergiants – for the lower mass range – or as a blue compact star – for the larger masses. The YSG phase is an intermediate, short-lived stage in the evolutionary models of single stars; no supernova explosion is expected to occur at this stage. Moreover, based on early optical emission and radio observations of SN2011dh, some studies claimed that the actual progenitor must have been a compact object. Therefore, the detected YSG star could have been a companion of the exploded star, or even an unrelated object that accidently matched the projected supernova location.

However the Kavli IPMU researchers presented evidence that the progenitor was an extended object of radius compatible with that of a YSG star. This was done by modeling its early-time optical emission using hydrodynamical calculations. As shown in Figure 1, the early observed emission is only reproduced based on the YSG star hypothesis. In March 2013, the HST imaging observational result that showed the disappearance of the YSG star was announced (Figure 2). The prediction by the Bersten group that the YSG would not be found was eventually confirmed by the observation.

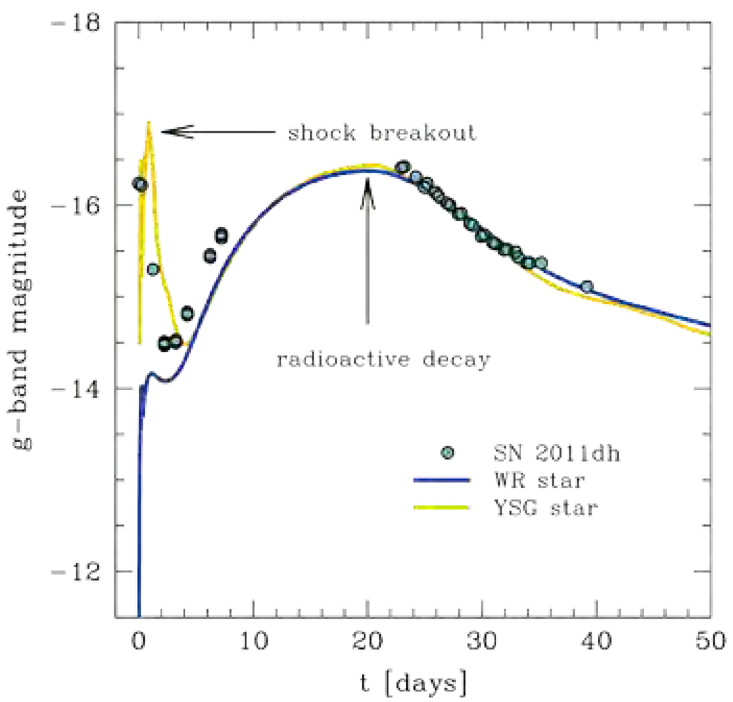


Figure 1: Theoretical light curve for a yellow supergiant (yellow) and blue compact (blue) progenitor compared with the observations of SN 2011dh (cyan points). From the figure it is clear that the progenitor of SN 2011dh should be a yellow supergiant in order to reproduce the observation.

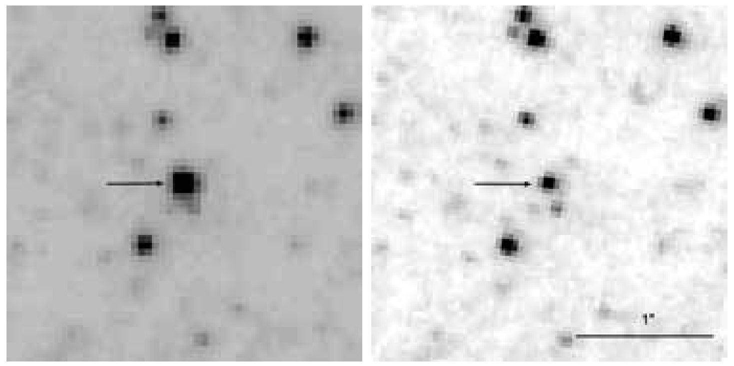


Figure 2: HST images obtained several years before (left) and almost two years after (right) the explosion of SN 2011dh. From the comparison between these two images it is evident that the yellow supergiant star present in the pre-explosion image has disappeared, and we now see a dimmer remnant of the supernova. This was reported in the Astronomical Telegram #4850 by Schuyler D. Van Dyk (IPAC/Caltech), Alexei V. Filippenko, Ori Fox, Patrick Kelly (UC Berkeley), and Nathan Smith (University of Arizona) [http://www.astronomerstelegram.org/?read=4850]. Image credit: Schuyler D. Van Dyk.

The findings from hydrodynamical calculations have led to two new questions that the Bersten et al. research group set out to answer: (1) how did the star lose most of its hydrogen envelope? and (2) how could a YSG star of those characteristics explode?

Related with the question (1), there are two main mechanisms proposed for stars to lose their outer layers: the strong winds and the mass transfer in interacting binary systems. For the former mechanism, it is believed that a star should have a mass at the time of birth, which is larger than approximately 25 times the mass of the Sun to generate winds strong enough to blow off its outer layers. Hydrodynamical models, however, set a strong constraint on the mass of a progenitor star. The findings showed that its core could have not been more massive than 8 times the mass of the Sun, which implies that the initial mass of the entire star should be less than 25 times the mass of the Sun. Thus, with the possibility of the winds ruled out, they tested the latter mechanism in which a progenitor transfers its mass to a close companion, thereby losing most of its outer envelope. The binary scenario has the advantage of introducing a reasonable mechanism for lower mass stars to expel their envelopes.

With the aim of solving both questions (1) and (2), the Bersten et al. research team carried out stellar evolution calculations for a system of two massive stars in a close orbit, in which phases of mass transfer occur. By assuming a system of stars with initial masses of 16 and 10 times the mass of the Sun and an initial period of 125 days (Figure 3), they were able to obtain a configuration for the mass-donor star – the one that eventually explodes – which closely matches the observations of the YSG object in pre-supernova images and has a core mass consistent with their hydrodynamical modeling. Moreover, the amount of hydrogen left in the envelope of the exploding star was in the correct range to classify the supernova as type IIb.

With the explosion of the YSG star confirmed, there is one last piece of the puzzle that still needs to be found: the existence of its companion star predicted

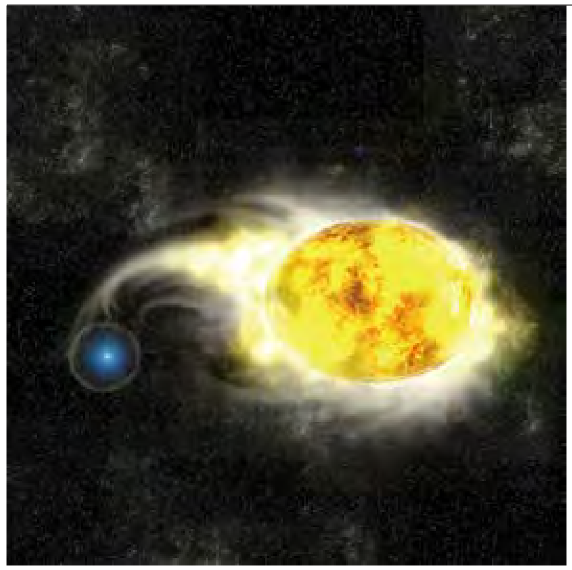


Figure 3: Artist's conception of the progenitor system of SN 2011dh. The system consists of a blue compact star and a yellow supergiant. Credit: Kavli IPMU/Aya Tsuboi

by the binary model. According to the calculations, the companion should become a massive blue star at the moment of the supernova explosion. Due to its high surface temperature, this star should emit radiation mostly lying in the ultraviolet range, with negligible contribution to the total flux of the system in the optical range. The companion was faint enough so that it was not detected in pre-supernova images of the space telescope. However, in the near future, as the supernova continues to fade, a relatively faint companion star should be discovered. The group at Kavli IPMU has thus proposed to perform deep ultraviolet observations with the HST in 2014 to provide a definitive test for the validity of their models.

6.4 Prediction of a Novel Phase Transition Inspired by Axion Search – An Interdisciplinary Collaboration between Researchers at the Kavli IPMU and the Institute of Solid State Physics (ISSP)

The axion is a hypothetical elementary particle beyond the Standard Model of Particle Physics, proposed to solve the problem of CP violation in strong interactions. The axion is also one of leading candidates for the dark matter of the universe.

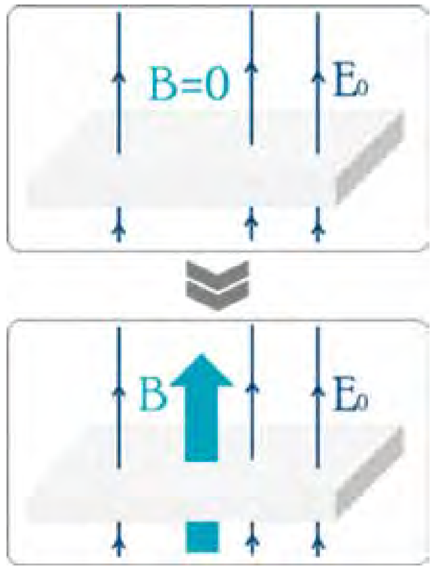
Many attempts have been made to detect the axion, for example, by applying a strong magnetic field, by converting the axion to the photon in a crystal of germanium, or by injecting high intensity laser beams in a strong magnetic field. However, none of the experiments has identified a positive signature of the axion yet. Hirosi Ooguri, Principal Investigator of the Kavli IPMU, introduced a new strategy to detect the axion, which involves a strong electric field instead of magnetic field. However, the required electric field turned out to be too strong to realize his idea with existing experimental technologies.

It was when Ooguri had a chance encounter with Professor Masaki Oshikawa of the Institute for Solid State Physics, that led Ooguri's idea applied to condensed matter physics.

Quantum field theory is a basic mathematical framework of elementary particle physics; this framework is also used to study critical phenomena in condensed matter systems. For example, the Ising model in two dimensions at criticality is described by a massless free fermion. Remarkably, there is a condensed matter system whose low energy description involves a coupled system of the axion and the electromagnetic field of the axion electrodynamics.

A topological insulator is a new type of material that behaves as an insulator in its interior but whose surface contains conducting states. Its existence was predicted by theorists in 2005 and actual materials realizing this mechanism were discovered recently. It turns out that magnetic fluctuation in a topological insulator can be effectively described by a system involving the Maxwell field, which is coupled to a particle behaving like the axion. This axion like particle is not the same as the axion in particle physics, but it shares many characteristics with the elementary particle axion.

Ooguri and Oshikawa studied the axion electrodynamics in the presence of a background electric field. They theoretically found that system possesses instability in a strong electric field, which leads to a phase transition as shown in the figure. Beyond the transition, the electric field is screened above a certain field strength and excess energy converted to a magnetic field. This phenomenon had not been known before their paper published. Furthermore, they pointed out the possibility of observation of this phenomenon experimentally in the solid state, using topological and other insulators.



In the absence of an externally-applied magnetic field, no magnetic field (B) exists before the axion phase transition takes place. As a consequence of the axion phase transition, a magnetic field appears. The direction of the magnetic field is perpendicular to the surface of the material and can be either upwards or downwards.

In contrast to the elementary particle axion, whose parameters should be determined by the nature, physical parameters of the axion field in the condensed matter experiments can be selected by adjusting doping materials. Especially, when the effective mass of the axion is reduced, the possibility to observe the phase transition will be raised. It is pointed out that such new phenomena will appear also in the usual (non-topological) insulator depending on the combination of magnetic and electric fields.

Their research result was published in Physical Review Letters (Phys. Rev. Lett. **108**, 161803 (2012)) as the first publication by a joint research between Kavli IPMU and ISSP. The paper was selected for Editors Suggestion "based on the potential interest in the results presented and, importantly, on the success of the paper in communicating its message, in particular to readers from other fields".

This new discovery is the result of the accumulation of research knowledge in both of these fields and was made possible by the cooperation of the Kavli IPMU and ISSP, both at the Kashiwa campus. Such on-campus interdisciplinary exchanges are expected to stimulate many more great research achievements in the future.

6.5 Extraordinary Magnification of a Type Ia Supernova

A research team at the Kavli IPMU has identified the first ever Type Ia supernova (SNIa) magnified by a strong gravitational lens. The discovery provides the first glimpse of the science that will soon come out of deep, wide-field surveys with the Subaru Hyper Suprime-Cam and the Large Synoptic Survey Telescope (LSST).

The supernova, named PS1-10afx, was uncovered by the Panoramic Survey Telescope & Rapid Response System 1 (Pan-STARRS1). Soon after it appeared, a team of scientists led by researchers at the Harvard-Smithsonian Center for Astrophysics realized that this supernova was special. Because the expansion of the Universe results in "redshift" that stretches short wavelength (blue) light to longer (red) wavelengths, the very red color of PS1-10afx suggested a very distant source. A spectrum taken a few days after discovery shows the telltale signature of interstellar gas near the supernova, and this sets the redshift firmly at z=1.3883, which corresponds to a distance of 9 billion light years – far further than typical Pan-STARRS1 discoveries.

Based on this distance and its relatively bright appearance, the Harvard team concluded that PS1-10afx was intrinsically very luminous. The inferred luminosity, about 100 billion times greater than our Sun, is comparable to members of a new, rare variety of superluminous supernovae (SLSNe), but that is where the similarities end. SLSNe typically have blue colors, and their brightness changes relatively slowly with time. PS1-10afx on the other hand was rather red even after correcting for its redshift, and its brightness changed as fast as normal supernovae. There is no known physical model that can explain how a supernova could simultaneously be so luminous, so red, and so fast.

Soon after the Harvard team announced their findings, Robert Quimby, a postdoctoral researcher at Kavli IPMU, independently analyzed the data. Quimby is an expert in SLSNe and has played a key

Research Highlights

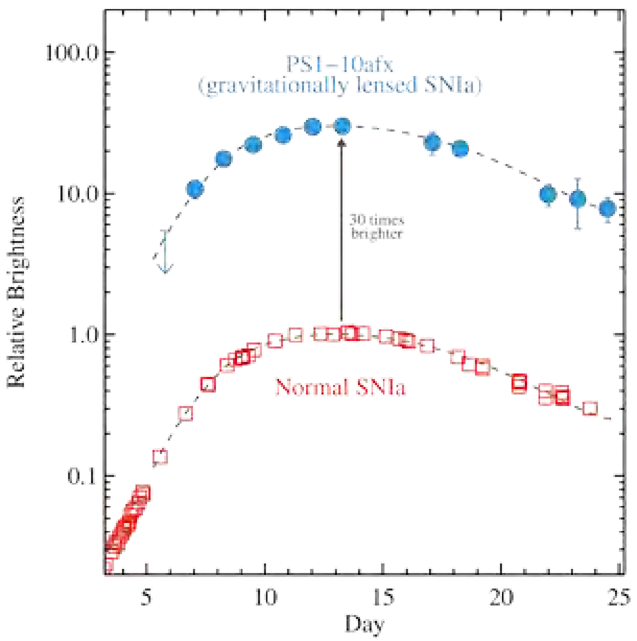
role in their discovery. He quickly confirmed a part, but not all of the Harvard team's conclusions. PS1-10afx was indeed rather distinct from all known SLSNe, but the data struck Quimby as oddly familiar. He compared the features seen in the spectra of PS1-10afx to normal supernova, and, surprisingly, found an excellent match. The spectra of PS1-10afx are almost identical to normal SNIa.

SNIa's have a very useful property that has enabled cosmologists to chart the expansion of our Universe over the last several billion years: there is a tight relation between how slowly SNIa's change in brightness with time and how intrinsically luminous they are. Higher luminosity SNIa's have broader light curves (a graph of their brightness curves over time), and fainter SNIa's have shorter light-curve widths.

So how does the light curve of PS1-10afx compare to a SNIa? After correcting for time dilation (another consequence of our expanding Universe), the light-curve width of PS1-10afx is perfectly consistent with a SNIa of normal luminosity, but the observed brightness of PS1-10afx is far too high for such a distant SNIa (see the first figure).

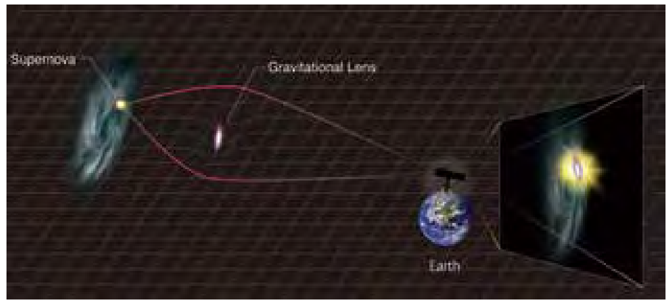
Tapping into the mathematical and astrophysical know-how at Kavli IPMU, Quimby's team found an explanation: the anomalously high brightness could indicate that PS1-10afx was gravitationally lensed by an object between us and the supernova. While light travels through space in "straight" lines, massive objects warp space and thus cause rays of light to "bend" around them. Thus if there is a sufficiently massive object aligned between us and PS1-10afx, light rays that would have gone off to other parts of the cosmos will be focused on us, making PS1-10afx appear brighter (see the second figure). This does not change the colors or spectra of the lensed object, nor does it change how fast the supernova evolves. The supernova simply appears brighter than it would otherwise be, just as was observed for PS1-10afx.

The Kavli IPMU team's identification of the first strongly lensed SNIa is unprecedented but not entirely unexpected. Masamune Oguri, one of the co-authors of Quimby's team, took the lead in writing a paper a few years ago predicting that Pan-STARRS1 was capable of discovering strongly lensed SNIa's. He has also shown that such objects may be exploited to place precise constraints on the cosmology of the Universe. Now that Quimby's team has shown how to identify them, next generation surveys with the Hyper Suprime-Cam on Subaru and the planned LSST can be tuned to discover even more strongly lensed SNIa's. These discoveries can be used to study the nature of dark mater, test theories of gravity, and help reveal what our universe is made of.



The light curve of PS1-10afx compared to a normal SNIa.

The blue dots show the observations of PS1-10afx through a red (i-band) filter, which corresponds to ultra-violet (UV) light in the rest frame of the supernova. The red squares show UV observations of the nearby SNIa, 2011fe compressed slightly along the time axis to match the width of PS1-10afx in its rest frame. The dashed lines show a fit to the SN 2011fe data and this same curve shifted by a constant factor of 30. The good agreement with the PS1-10afx data shows that PS1-10afx has the light curve shape of a normal SNIa, but it is 30 times brighter than expected.



Schematic illustration of the magnification of PS1-10afx.

A massive object between us and the supernova bends light rays much as a glass lens can focus light. As more light rays are directed toward the observer than would be without the lens, the supernova image is magnified. Credit: Kavli IPMU.

6.6 The Pure Gravity Mediation Model

After the discovery of a new boson at the Large Hadron Collider (LHC) experiment, which seems strongly to be the higgs boson predicted by the standard model (SM), people has again started considering new physics beyond the SM carefully. One of the most striking results in this discovery is that its mass is observed at about 125 GeV, which means that the new physics is presumably described by a weakly interacting theory. Among several weakly interacting theories, supersymmetry (SUSY) is the most promising candidate for the new physics. When SUSY particles exist within a TeV range as expected in the pre-LHC era, however, the higgs mass of 125 GeV is difficult to be achieved. This fact means that rather large SUSY breaking effects to the higgs self-coupling are mandatory and requires a typical mass scale of sparticles such as squarks and slepton to be around 100 TeV. Interestingly, this possibility was pointed out by Okada, Yamaguchi, and Yanagida more than twenty years ago. Such high-mass sparticles are very compatible with non-observation of SUSY signals at the LHC and of FCNC processes at flavor-related experiments.

As a downside of the high-mass sparticles, we lose a good candidate for dark matter in the SUSY standard model. That is, when dark matter is one of the sparticles with a mass at around the 100 TeV scale, energy density of dark matter is too high and not consistent with the recent observation of the dark matter relic density in our universe. This problem is, however, naturally resolved when we consider the simplest setup of SUSY breaking. Suppose that the breaking is caused by a non-singlet SUSY breaking field with the gravitino mass being $O(100)$ TeV and its effect is simply mediated by supergravity interactions. Then all scalar sparticles and higgsinos acquire their masses at tree level and those are predicted to be $O(100)$ TeV. On the other hand, gaugino masses come from the one-loop anomaly mediated contribution, as already discussed by Giudice, Luty, Murayama, and Rattazzi fifteen years ago.

This model is very attractive from the viewpoint of cosmology. First, neutral gauginos can be a good candidate for dark matter because their masses are suppressed by one-loop factor compared to the gravitino mass. Second, we are free from the gravitino problem because the gravitino with the mass of $O(100)$ TeV decays well before the big-bang nucleosynthesis. Third, the so-called Polonyi problem does not exist because there is no singlet field in the SUSY breaking sector. Finally, the model is consistent with the leptogenesis scenario proposed by Fukugita and Yanagida, which is now regarded as the most successful mechanism to generate the baryon asymmetry of the universe with being consistent with tiny neutrino masses and their mixings. This model is now called the pure gravity mediation model (PGM).

Basic framework and the fact that the PGM is compatible with the higgs mass of 125 GeV were first discussed by Ibe and Yanagida. Soon after that, the entire framework of the PGM and its certain phenomenological aspects were discussed by Ibe, Matsumoto, and Yanagida. Both two studies have been done at Kavli IPMU. One of the important predictions of the PGM is that all gauginos are at or less than $O(1)$ TeV and are within the accessible range of current and future collider experiments, while all other sparticles are much beyond this range.

Another important prediction is that the neutral wino is the lightest supersymmetric particle, namely a candidate for dark matter, in the most of parameter region of the PGM. The neutral wino is highly degenerate with the charged wino in mass. The charged wino has therefore a long decay length of $O(1$-$10)$ cm, which provides distinct signatures of the PGM at collider experiments. Due to a high experimental sensitivity to the mass degeneracy, a precise calculation of the mass difference between these two was found to be important and was recently performed at the two-loop level by Ibe, Matsumoto, and Sato at Kavli IPMU.

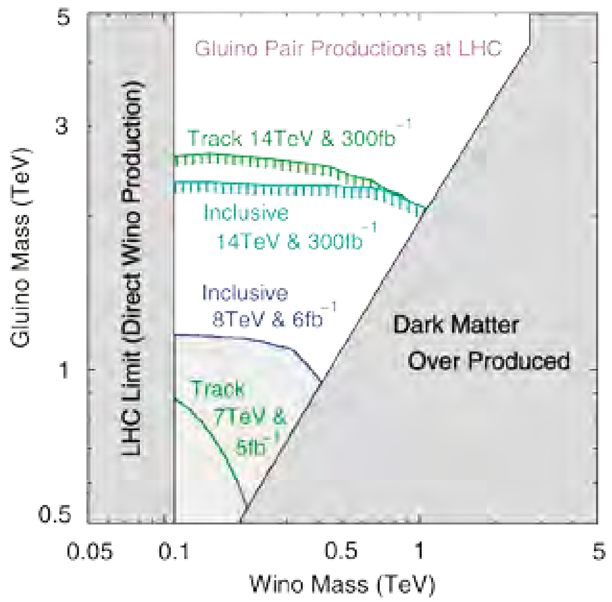
After the model-building of the PGM, some detailed studies on its phenomenology were also carried out at Kavli IPMU, and the following results have been obtained.

For the collider (LHC) physics, the following three processes are expected at the LHC to test the PGM. The first one is the inclusive process of gluino pair productions, where a gluino decays into a neutral or charged wino by emitting two quarks. This process currently gives a lower limit on the gluino mass as $m_{\rm gluino} > 1.2$ TeV. When the LHC accumulates 300 $\rm fb^{-1}$ data at the 14 TeV run, the process will cover the gluino mass up to 2.3 TeV. The next one is again the process of gluino pair productions but now with a disappearing track signal of charged wino decays. Though this process is not stronger than the inclusive one at present, it will play an important role in near future. The last one is the direct production of the charged wino through electroweak interactions, where the disappearing track signal is again considered. It currently gives a lower limit on the wino mass as $m_{\rm wino} > 110$ GeV. All these analyses have been performed by Bhattacherjee, Feldstein, Ibe, Matsumoto, and Yanagida at Kavli IPMU. The first figure shows some details of the results obtained in these analyses.

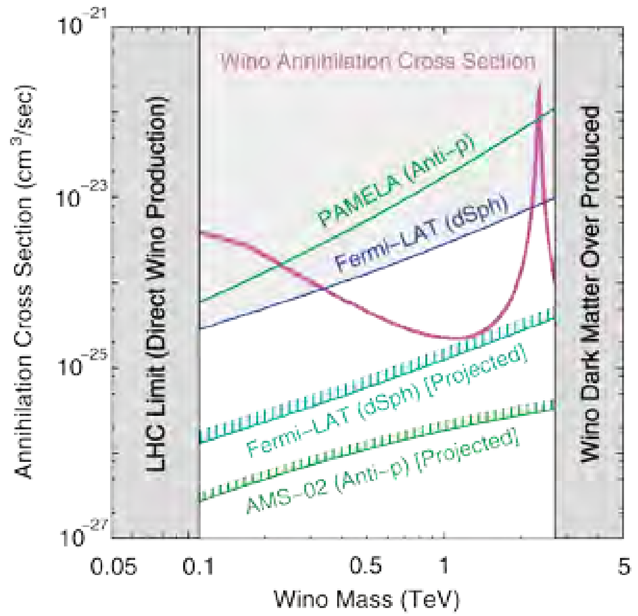
Another interesting phenomenology of the PGM is found in dark matter detections, because the model predicts a neutral wino dark matter which has an annihilation cross section highly boosted by the Sommerfeld enhancement, as pointed out by Hisano, Matsumoto and Nojiri about ten years ago. As a result, the PGM can be tested in indirect detection experiments of dark matter such as Fermi-LAT, PAMELA and AMS-02. The detection using cosmic-ray anti-protons was discussed in the study mentioned above, and it turned out that the AMS-02 will cover the whole parameter region of the PGM. The detection using gamma-rays from Milky Way satellites has also been studied recently by Bhattacherjee, Ibe, Ichikawa, Matsumoto and Nishiyama very carefully, and it has been found that the whole parameter region can be covered at the Fermi-LAT when kinematical data of ultra-faint dwarf spheroidals are sufficiently increased. Currently, this detection gives the most severe limit on the wino mass as $m_{\rm wino} > 300$ GeV. The second figure shows some details obtained in these studies. It is also worth noting that Ibe, Kamada, and Matsumoto pointed out that the wino dark matter may have some fraction of warm component if its mass is less than 500 GeV; it may be detected in future 21cm observations.

The PGM is now known to be one of the most interesting candidates for new physics beyond the SM, and in fact it is frequently cited all over the world. As already mentioned above, the model was built based on several of the important past studies on SUSY made by those who are now at Kavli IPMU. In addition, much of the recent progress on this model is currently being made at Kavli IPMU.

For further details, see M. Ibe, S. Matsumoto, and R. Saito, Phys. Lett. B **721**, 252 (2013).



Present LHC constraints on wino and gluino masses are shown, where the shaded regions have already been excluded at 95% confidence level. Future expected sensitivities for an inclusive process and those using the disappearing track are also shown, where the date corresponding to an integrated luminosity of 300 $\rm fb^{-1}$ at 14 TeV run is assumed.



Present constraints on the wino mass from indirect detection measurements of dark matter are shown, where the shaded regions have already excluded at 95% confidence level. Future expected sensitivities at Fermi-LAT and AMS-02 experiments are also shown.

7 Awards

David Spergel (left) and Eiichiro Komatsu (right) were among the twenty six members of the WMAP (Wilkinson Microwave Anisotropy Probe) team that won the Gruber Foundation's 2012 Cosmology Prize, jointly with Charles L. Benett of Johns Hopkins University. The WMAP project brought precise and accurate understandings of the age, content, geometry and origin of the universe, and led to the firm foundation of the Standard Cosmological Model. The citation recognized that the exquisite specificity of these results had helped transform cosmology itself from "appealing scenario into precise science."

Komatsu also won the 2012 Lancelot M. Berkeley – New York Community Trust Prize for Meritorious Work in Astronomy. The prize is given annually to highly meritorious work in advancing the science of astronomy during the previous year. He received the prize for his paper, "Seven-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretation." Komatsu has been a member of the WMAP team since 2001 and was the first author of the papers presenting the cosmological interpretation of their five- and seven-year data sets.

Hirosi Ooguri won the Inaugural Simons Investigator Award. Ooguri receives more than 1.3 million US dollars over the next ten years for his research. The goal of this new program is "to provide a stable base of support for outstanding scientists in their most productive years, enabling them to undertake long-term study of fundamental questions." Nine theoretical physicists, seven mathematicians, and five computer scientists were appointed as Simons Investigators. Each recipient will be granted funds to be applied to their individual research, their department, and their institution for an initial period of five years, beginning August 2012. The foundation anticipates renewing the grants for an additional five years in 2017. Ooguri was recognized in the citation as a "mathematical physicist and string theorist of exceptional creativity and breadth." He was chosen as an investigator for his "innovations in the use of topological string theory to compute Feynman diagrams in superstring models," as well as for his cutting-edge work on the relationship of supersymmetric gauge theories to string theory and to gravity.

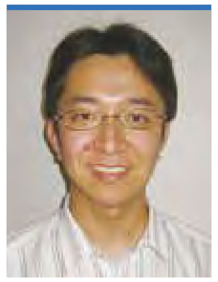
Ooguri was also selected to join the inaugural group of Fellows of the American Mathematical Society (AMS). The AMS Fellows program recognizes members who have made outstanding contributions to the creation, exposition, advancement, communication, and utilization of mathematics. The responsibilities of Fellows are to take part in the election of new Fellows, to present a "public face" of excellence in mathematics, and to advise the President and the Council on public matters when requested.

The 2012 Geometry Prize of the Mathematical Society of Japan is awarded to Yukinobu Toda for "The study of the Donaldson-Thomas invariants by stability conditions in derived categories." The Geometry Prize was established in 1987 by the donation by a group of researchers in geometry. This prize is awarded to researchers who have contributed to the development of geometry in a broad sense by obtaining outstanding results.

Kunio Inoue won the 2012 Nishina Memorial Prize. He has been playing a leading role in the KamLAND (Kamioka liquid scintillator anti-neutrino detector) experiment, and, in particular, he has been making efforts to reduce various backgrounds in the KamLAND detector by substantially improving it. These efforts have led to the first observation of terrestrial anti-neutrinos (geoneutrinos) originating from radioactive decays of uranium and thorium inside the earth in 2005. Subsequently in 2011, the KamLAND experiment measured substantially less radiogenic heat production in the earth with respect to the surface heat flow, and consequently showed direct evidence for secular cooling of the earth. The Foundation said, "His successful works explore interdisciplinary researches using neutrinos and are the foundations of development of neutrino geophysics by direct observation of inside the earth."

He was also awarded the 4th Yoji Totsuka Memorial Prize jointly with Atsuto Suzuki, Director General of High Energy Accelerator Research Organization (KEK), for "Neutrino research with liquid scintillator, observation of geologically produced anti-neutrinos". This prize has been awarded annualy since 2010 by the Heisei Foundation for Basic Science.

Brice Ménard was selected by the Maryland Academy of Sciences as the 2012 Outstanding Young Scientist. He was recognized for his research in extragalactic astrophysics and cosmology. The award program was established in 1959 to recognize and celebrate the extraordinary contributions of young Maryland researchers across all fields of science.



Masahiro Takada received the 2012 PASJ Excellent Paper Award jointly with his collaborators for their paper entitled "LoCuSS: Subaru Weak Lensing Study of 30 Galaxy Clusters," which was published in PASJ in 2010. The PASJ Excellent Paper Award is given to ingenious and excellent papers that appeared in the PASJ (Publications of Astronomical Society of Japan) within the past five years and made significant contribution to the field of astronomy. One of the coauthors Nobuhiro Okabe, now at the Academia Sinica Institute of Astronomy and Astrophysics, will join Kavli IPMU in fall 2013.

Masayuki Tanaka received the ASJ 2012 Young Astronomer Award for his contribution to the investigation of "evolution of galaxy populations and AGN activities in distant clusters of galaxies." This award is presented by the Astronomical Society of Japan to up to three young astronomers who are under 36 years old and achieved excellent research results.

8 Seminars

JFY2012

Daniel Green (IAS)
Measuring the Particle Spectrum During Inflation
Apr 04, 2012

Jens Hoppe (KTH Royal Inst of Technology)
Membrane Theory and Discrete Differential Geometry
Apr 05, 2012

Duco van Straten (U Mainz)
Conifold-Period Expansions
Apr 06, 2012

Rene Meyer (U Crete)
Parity Breaking Hydrodynamics in 2+1 Dimensions and Axions in AdS
Apr 10, 2012

Jeremy Mould (Swinburne U)
Mapping the Dark Matter with recent redshift surveys
Apr 11, 2012

Frederic P Schuller (Albert Einstein Inst)
Spacetimes beyond Einstein
Apr 11, 2012

Frederic Schuller (MPI for Gravitational Physics)
Introduction to area metric geometry and its emergence in physics
Apr 12, 2012

Fabian Schmidt (Caltech)
Probing Gravity with Large-Scale Structure
Apr 12, 2012

Kyoji Saito (Kavli IPMU)
Growth functions for cancellative monoids
Apr 12, 2012

Kentaro Nagao (Nagoya U)
Hyperbolic 3-manifolds and Cluster Algebras
Apr 16, 2012

Yuji Tachikawa (U Tokyo)
An introduction to Seiberg-Witten Theory for mathematicians
Apr 17, 2012

Kazunori Nakayama (U Tokyo)
Cosmological Aspects of Inflation in a Supersymmetric Axion Model
Apr 18, 2012

Piet Hut (IAS)
The Program in Interdisciplinary Studies at IAS
Apr 19, 2012

Susanne Reffert (CERN)
2d Gauge/Bethe correspondence from String Theory
Apr 24, 2012

Yuji Tachikawa (U Tokyo)
An introduction to Seiberg-Witten Theory for mathematicians
Apr 24, 2012

Ernest Ma (UC Riverside)
Dark Vector Boson from E6 /SU (2)N Extension of Standard Model
Apr 25, 2012

Marcus Werner (Kavli IPMU)
Optical Geometry
Apr 26, 2012

Domenico Orlando (CERN)
The Omega Deformation from String and M-Theory
May 01, 2012

Yuji Tachikawa (U Tokyo)
An introduction to Seiberg-Witten Theory for mathematicians
May 01, 2012

Shintaro Yanagida (RIMS)
Bridgeland's stabilities on abelian surfaces
May 07, 2012

Dan Xie (IAS)
General Argyres-Douglas theory
May 08, 2012

Yuji Tachikawa (U Tokyo)
An introduction to Seiberg-Witten Theory for mathematicians
May 10, 2012

George Efstathiou (U Cambridge)
Early Results from Planck
May 10, 2012

Changzheng Li (Kavli IPMU)
A mirror symmetric construction of quantum cohomology of flag varieties
May 10, 2012

Andrea Prudenziati (YITP)
Looking for a worldsheet description of the Nekrasov partition function
May 15, 2012

Atsushi Taruya (U Tokyo)
Gravitational-wave backgrounds from ground and space-based interferometers
May 15, 2012

Douglas Spolyar (Fermilab)
Dark Matter and Light
May 16, 2012

Yuji Tachikawa (U Tokyo)
An introduction to Seiberg-Witten Theory for mathematicians
May 17, 2012

Marta Volonteri (Inst Astrophys Paris)
Massive black holes in galaxy mergers: accretion and dynamics
May 17, 2012

David Skinner (Perimeter Inst)
The Secret Life of Scattering Amplitudes
May 21, 2012

Emanuel Scheidegger (U Freiburg)
Topological Strings on Elliptic Fibrations
May 21, 2012

Masataka Chida (Kyoto U)
Anticyclotomic p-adic L-functions for modular forms
May 22, 2012

Norimi Yokozaki (Kavli IPMU)
125 GeV Higgs in Gauge Mediation Models
May 23, 2012

Yuji Tachikawa (U Tokyo)
An introduction to Seiberg-Witten Theory for mathematicians
May 24, 2012

Scott Carnahan (Kavli IPMU)
Monstrous moonshine and generalized moonshine
May 24, 2012

Yoshitake Hashimoto (Tokyo City U)
Conformal Field Theory Associated to C2-cofinite Vertex Operator Algebras (jointly with Professor Akihiro Tsuchiya)
May 26, 2012

Akihiro Tsuchiya (Kavli IPMU)
Extended W algebra of type A.D.E. at positive rational level
May 26, 2012

Massimo Marengo (Iowa State U)
Blowing a Standard Candle: the Disappearing Mass of delta Cephei
May 28, 2012

Jeff Cooke (Swinburne U)
Supernovae discoveries in the early Universe
May 29, 2012

Katsuyuki Naoi (Kavli IPMU)
The X=M conjecture for a quantum affine algebra
May 29, 2012

Sergio Palomares Ruiz (CFTP)
Beyond dark matter detection with neutrino telescopes
May 30, 2012

Emiliano Molinaro (CFTP)
Low Energy Signatures of TeV scale See-Saw Mechanism
May 30, 2012

Anna Frebel (MIT)
Stellar Archaeology: New Science with Old Stars
May 30, 2012

Tarig Abdelgadir (KIAS)
Quivers of sections on toric orbifolds
Jun 04, 2012

Raphael Bousso (UC Berkeley)
Eternal Inflation and the Measure Problem
Jun 05, 2012

Yuji Tachikawa (U Tokyo)
An introduction to Seiberg-Witten Theory for mathematicians
Jun 05, 2012

Harald Fritzsch (LMU Munich)
Composite Weak Bosons at the LHC
Jun 06, 2012

Siu-Cheong Lau (Kavli IPMU)
Open GW invariants of toric manifolds
Jun 07, 2012

Marco Valdes (SNS de Pisa)
High redshift 21 cm signal as a dark matter probe
Jun 07, 2012

Uros Seljak (Berkeley/Zurich/IEU)
Recent developments in galaxy-dark matter clustering connection
Jun 08, 2012

Bong Lian (Brandeis U)
Period Integrals and Tautological Systems
Jun 08, 2012

Changzheng Li (Kavli IPMU)
Quantum cohomology of flag varieties
Jun 11, 2012

Arman Esmaili Taklimi (UNICAMP)
Indirect Dark Matter Detection in the Light of Sterile Neutrinos
Jun 13, 2012

Yongbin Ruan (U Michigan)
Gromov-Witten theory of Calabi-Yau spaces I
Jun 15, 2012

Huai-Liang Chang (HKUST)
Introduction to Gromov Witten and Fan-Jarvis-Ruan-Witten theory
Jun 18, 2012

Yongbin Ruan (U Michigan)
Gromov-Witten theory of Calabi-Yau spaces II
Jun 19, 2012

Yuji Tachikawa (U Tokyo)
An introduction to Seiberg-Witten Theory for mathematicians
Jun 19, 2012

Tetsuya Shiromizu (Kyoto U)
Asymptotic flatness of higher dimensional spacetimes
Jun 20, 2012

Yongbin Ruan (U Michigan)
Mirror symmetry and modular form
Jun 20, 2012

Minoru Nagai (U Tokyo)
2HDM MFV Facing Recent LHCb Data
Jun 27, 2012

Roderik Overzier (UT Austin)
Real Galaxies & Virtual Universes
Jun 27, 2012

Maximilian Stritzinger (Aarhus/Stockholm)
Multi-wavelength Observations of the Enduring Type IIn Supernovae 2005ip and 2006jd
Jun 28, 2012

Donghui Jeong (JHU)
New ways of searching for the primordial gravitational wave from large scale structure
Jun 29, 2012

Daniel Halpern-Leistner (UC Berkeley)
The derived category of a GIT quotient
Jul 02, 2012

Nao Suzuki (LBNL)
Towards the Era of High Precision Cosmology
Jul 02, 2012

Yuken Miyasaka (Tohoku U)
Torsion points on Jacobian varieties and p-adic Sato theory
Jul 03, 2012

Tsutomu Yanagida (Kavli IPMU)
Why do I believe in SUSY more strongly than before the LHC?
Jul 04, 2012

Satoshi Kondo (Kavli IPMU)
On the rational K2 of a curve of GL2 type over the function field of a curve over a finite field
Jul 05, 2012

Yuji Tachikawa (U Tokyo)
An introduction to Seiberg-Witten Theory for mathematicians
Jul 10, 2012

Marco Peloso (U Minnesota)
Phenomenology of a pseudoscalar inflaton: naturally large non-gaussianity
Jul 11, 2012

Elizabeth Tasker (Hokkaido U)
How to kill a giant molecular cloud (GMC)
Jul 12, 2012

Koji Nakamura (CERN)
Latest Results on the Standard Model Higgs Searches at the LHC
Jul 13, 2012

Eiichiro Komatsu (MPA/Kavli IPMU)
New probes of initial state of quantum fluctuations during inflation
Jul 13, 2012

Hitoshi Murayama (Kavli IPMU)
Unified description of Nambu-Goldstnoe Bosons without Lorentz invariance and Presymplectic Geometry
Jul 17, 2012

David Morrison (UCSB)
Fermions for mathematicians
Jul 20, 2012

David Morrison (UCSB)
F-theory on genus one fibrations
Jul 23, 2012

John Ellis (CERN)
To Higgs or not to Higgs? That is one of the questions
Jul 23, 2012

Masaki Asano (U Hamburg)
Naturalness in SUSY models and LHC results
Jul 25, 2012

Naoki Yoshida (U Tokyo/Kavli IPMU)
Observational Cosmology: Evolution of the Universe over 13.7 billion years
Jul 25, 2012

Yuji Satoh (Tsukuba U)
Conformal/supersymmetric interfaces for string theory
Jul 31, 2012

Chihway Chang (Stanford U)
Drawing Photons from the Future – the LSST Photon Simulator and Shear Systematics Studies
Jul 31, 2012

Leonardo Mihalcea (Virginia Tech)
Quantum K-theory and the geometry of spaces of curves
Jul 31, 2012

Juergen Fuchs (Karlstad U)
Correlation functions in conformal field theory
Aug 07, 2012

Juergen Fuchs (Karlstad U)
Mapping class group invariants from factorizable Hopf algebras
Aug 07, 2012

Lorenzo Ubaldi (U Bonn)
WIMP dark matter and baryogenesis
Aug 08, 2012

Tathagata Basak (Iowa State U)
From a finite projective plane to the monster via hyperbolic geometry
Aug 09, 2012

Tomoyuki Abe (Kavli IPMU)
Theory of weight in arithmetic geometry
Aug 09, 2012

Paul Steinhardt (Princeton U)
Quasi-crystals
Aug 10, 2012

Paul Steinhardt (Princeton U)
What Next In Cosmology
Aug 13, 2012

Mikhail Kapranov (Yale U)
Cubic relations in Hall algebras and roots of zeta functions
Aug 15, 2012

Tevong You (Imperial College London)
Is it a (Beyond the) Standard Model Higgs?
Aug 22, 2012

Takehiko Yasuda (Osaka U)
Motivic integration and the p-cyclic McKay correspondence
Aug 27, 2012

Charles Siegel (Kavli IPMU)
The Schottky problem in genus 5
Aug 28, 2012

Kazuki Sakurai (DESY)
Constraining low energy supersymmetry beyond CMSSM
Aug 29, 2012

Rak-Kyeong Seong (Imperial College)
Brane Tiling mutations and beyond
Sep 04, 2012

Matteo Cantiello (KITP)
Long gamma-ray burst progenitors throughout cosmological time
Sep 05, 2012

Ryo Namba (U Minnesota)
Characteristic signatures in non-gaussianity and statistical anisotropy from vector fields during inflation
Sep 06, 2012

Yasuyoshi Yonezawa (Nagoya U)
Quantum $(sl_n, \wedge V_n)$ link invariant and matrix factorizations
Sep 10, 2012

Martin Bureau (U Oxford)
Molecular gas and star formation in early-type galaxies
Sep 13, 2012

Todor Milanov (Kavli IPMU)
W-constraints for the total descendant potential of a simple singularity
Sep 13, 2012

Grigoris Panotopoulos (OIST)
The accelerating Universe, and the cosmic mystery of Dark Energy
Sep 19, 2012

Tommaso Treu (UC Santa Barbara)
Black holes, Dark Energy, and other Dark Matters
Sep 21, 2012

Ivan Ip (Kavli IPMU)
Positive Representations of Split Real Quantum Groups
Sep 21, 2012

Ruth Gregory (U Durham)
Lifshitz Solutions in String Theory
Sep 26, 2012

Yukinobu Toda (Kavli IPMU)
MMP via stability conditions
Sep 27, 2012

Jillian Scudder (U Victoria)
Tracing the effects of gas flows in interacting galaxy pairs
Oct 02, 2012

Anton Kapustin (Caltech)
Three-dimensional Seiberg duality and generalizations of the Verlinde algebra
Oct 02, 2012

Yi Wang (Kavli IPMU)
Isocurvatons during inflation: the heavy, the quasi-and the light
Oct 02, 2012

Pierre Schapira (U Pierre et Marie Curie)
Hochschild classes and microlocal Euler classes of sheaves and D-modules (joint work with Masaki Kashiwara)
Oct 03, 2012

Henry Tye (Cornell U)
A Stringy Mechanism for a Small Cosmological Constant
Oct 03, 2012

Hisakazu Minakata (Tokyo Metropolitan U)
Neutrinos: Kage-Musha in nature which however have a key to understand her fundamental structure
Oct 03, 2012

Liam McAllister (Cornell U)
The Wasteland of Random Supergravities
Oct 09, 2012

Pedro Vieira (Perimeter Inst)
4D Wilson Loops, 2D Flux Tubes and Integrability
Oct 09, 2012

Kurt Hinterbichler (Perimeter Inst)
Developments in massive gravity
Oct 09, 2012

Francesco Benini (SUNY Stony Brook)
S2 partition functions: Coulomb vs Higgs localization and vortices In two-dimensional N=(2,2)
Oct 10, 2012

Eung Jin Chun (KIAS)
LHC Phenomenology of Type II Seesaw
Oct 10, 2012

Masahito Yamazaki (Princeton U)
New Perspectives on SCFTs
Oct 10, 2012

Valentin Tonita (Kavli IPMU)
Twisted Gromov-Witten invariants
Oct 11, 2012

Kurt Hinterbichler (Perimeter Inst)
The pseudo-conformal universe
Oct 16, 2012

Mark Trodden (U Pennsylvania)
Galileons and their Generalizations
Oct 17, 2012

Daniel Jafferis (Harvard U)
Exact results in supersymmetric conformal field theories
Oct 23, 2012

Satyanarayan Mukhopadhyay (Kavli IPMU)
Effective couplings of the Higgs boson in the light of recent LHC and Tevatron data
Oct 24, 2012

Kenji Fukaya (Kyoto U)
Involutive bi-Lie infinity structure and Floer homology of arbitrary genus
Oct 24, 2012

David Wake (Yale U)
What turns galaxies off ? - Revealing the links between galaxy color, structure and dark matter halo property
Oct 24, 2012

Kenji Fukaya (Kyoto U)
Applications of Cardy relation to symplectic geometry
Oct 25, 2012

Ruediger Pakmor (HITS)
Simulations of Type Ia Supernova Explosions
Oct 25, 2012

Kenji Fukaya (Kyoto U)
When and how much can Lagrangian Floer theory determine Gromov-Witten invariant?
Oct 26, 2012

Bernd Schroers (Heriot-Watt U)
Geometric models of matter
Oct 26, 2012

Britt Lundgren (U Wisconsin)
Revealing the origins and environments of Mg II absorbers with the SDSS and 3D-HST
Oct 29, 2012

Daniel Pomerleano (Kavli IPMU)
Conifold Transition in the Landau-Ginzburg B-model
Oct 29, 2012

Mauricio Romo (Kavli IPMU)
Two-Sphere Partition Functions and Gromov-Witten Invariants
Oct 30, 2012

Steve F. King (U Southampton)
A Higgs Boson Near 125 GeV Beyond the Minimal Supersymmetric Standard Model
Oct 30, 2012

Steve F. King (U Southampton)
Flavour Symmetry Models after Daya Bay and RENO
Oct 31, 2012

Alexey Bondal (Kavli IPMU / Steklov)
Mathematical theory of mutually unbiased bases
Oct 31, 2012

Marcelo Alvarez (CITA)
Effects of Radiative Feedback on Reionization and the Local Universe
Nov 01, 2012

Pawel Sosna (U Hamburg)
Construction of (quasi-)phantom categories on some surfaces of general type
Nov 05, 2012

Oliver Lorscheid (IMPA)
A problem of Jacques Tits and Chevalley groups over F1
Nov 06, 2012

Lukas Witkowski (U Oxford)
A story of de- and re-coupling: supersymmetry breaking in string models
Nov 07, 2012

Anastasia Fialkov (Tel Aviv U)
Detectable signature of first stars in 21-cm
Nov 08, 2012

Motohico Mulase (UC Davis)
Mirror Symmetry of Catalan Numbers and Quantum Curves
Nov 08, 2012

Edward Wright (UCLA)
The Wide-field Infrared Survey Explorer: Implementation and Solar System Science
Nov 12, 2012

Ramesh Sreekantan (Indian Statistical Inst)
Higher Chow cycles on Abelian surfaces
Nov 13, 2012

Alex Kusenko (UCLA / Kavli IPMU)
Light dark matter: the motivation, the theory, the ongoing search
Nov 14, 2012

Edward Wright (UCLA)
WISE Observations of Stars, Galaxies and Star Formation, and QSOs
Nov 16, 2012

Andrei Frolov (Simon Fraser U)
Understanding the shape of non-Gaussianity
Nov 19, 2012

Antonio Padilla (U Nottingham)
War on Lambda: fighting the cosmological constant problem
Nov 19, 2012

Piljin Yi (KIAS)
part 1: Algebra, Geometry, and Hydrogen Atom, part2: Wall-Crossing and Quiver Invariant
Nov 20, 2012

Brian Schmidt (Nobel Laureate in Physics in 2011) (Australian National U)
Supernovae, the Accelerating Cosmos, and Dark Energy
Nov 20, 2012

Tatsu Takeuchi (Virginia Tech)
Some Mutant Forms of Quantum Mechanics
Nov 21, 2012

Oleg Evnin (Chulalongkorn U)
Quantum backreaction in string theory
Nov 21, 2012

Dmitry Gorbunov (INR Moscow)
Experimental tests of R2-inflation and its minimal extensions
Nov 22, 2012

Toshitake Kohno (U Tokyo)
Quantum symmetry in homological representations of braid groups
Nov 22, 2012

Martin Schnabl (Inst of Physics ASCR)
Ising Model D-Branes from String Field Theory
Nov 26, 2012

Susanne Reffert (CERN)
BPS States in the Duality Web of the Omega deformation
Nov 27, 2012

Andrei Barvinsky (Lebedev Inst)
Density matrix of the universe and the CFT driven cosmology
Nov 27, 2012

Felix Bruemmer (DESY)
Supersymmetry with light higgsinos
Nov 28, 2012

Joel Meyers (UT Austin)
Non-Gaussianity and the Adiabatic Limit
Nov 28, 2012

Fedor Smirnov (LPTHE)
Form factors of descendant fields and null-vectors for sine-Gordon model
Nov 28, 2012

Hoi-lai Yu (Academia Sinica)
General Relativity without paradigm of space-time covariance, and resolution of the problem of time
Nov 29, 2012

Keisuke Izumi (LeCosPA)
Spherically symmetric analysis on open FLRW solution in non-linear massive gravity
Dec 03, 2012

Mikhail Shifman (U Minnesota)
Non-Abelian Strings in Supersymmetric Yang-Mills
Dec 03, 2012

Domenico Orlando (CERN)
Squashed group manifolds in String Theory. Brane realization and classical integrability
Dec 04, 2012

Kai Schmitz (Kavli IPMU)
The B-L Phase Transition as the Origin of the Hot Early Universe
Dec 05, 2012

Hiraku Nakajima (RIMS)
AGT conjecture
Dec 10, 2012

Jaewon Song (UCSD)
The ABCDEFG of Instantons
Dec 11, 2012

Takeshi Kobayashi (CITA)
Primordial Spikes from Wrapped Brane Inflation
Dec 11, 2012

Robert Brandenberger (McGill U)
Searching for Cosmic Strings in New Observational Windows
Dec 12, 2012

Marcus Werner (Kavli IPMU)
Gravitational Lensing and Topology
Dec 12, 2012

Alexie Leauthaud (Kavli IPMU)
Tackling Dark Energy, Dark Matter, and Galaxy Formation with Weak Gravitational Lensing
Dec 13, 2012

Zheng Hua (Kansas State U)
Spin structure on moduli space of sheaves on CY 3-folds
Dec 14, 2012

Jean-Philippe Uzan (Inst Astrophys Paris)
Testing local isotropy with weak lensing
Dec 18, 2012

Kazuo Fujikawa (RIKEN)
Lorentz invariant CPT violation and neutrino-atineutrino mass splitting in the Standard Model
Dec 19, 2012

Wayne Hu (KICP, Chicago)
Cosmic Acceleration and Modified Gravity
Dec 20, 2012

Satoshi Shirai (UC Berkeley)
“Unnatural” SUSY
Dec 26, 2012

Slava Rychkov (ENS Paris & CERN)
Bootstrap program for CFT in d ≥ 3: Status and Open Problems
Jan 08, 2013

Yu Nakayama (Caltech/Kavli IPMU)
Does anomalous violation of null energy condition invalidate holographic c-theorem?
Jan 08, 2013

Jing Shu (Inst Theo Phys, Chinese Academy of Sciences)
Implication of the current Higgs data and a composite Higgs
Jan 09, 2013

Mikhail Kapranov (Yale U)
Triangulations, Hall algebras and membrane spaces
Jan 17, 2013

Tanmay Neelesh Deshpande (Kavli IPMU)
Character sheaves on unipotent groups
Jan 17, 2013

Keith Olive (U Minnesota)
Effects of Strong Moduli Stabilization on Low Energy Phenomenology
Jan 21, 2013

Arend Bayer (U Edinburgh)
Birational geometry of moduli of sheaves on K3s via Bridgeland stability
Jan 21, 2013

Takahiko Matsubara (Nagoya U)
The Integrated Perturbation Theory for the Largescale Structure of the Universe
Jan 22, 2013

Christophe Grojean (CERN)
Quo Vadis Higgs?
Jan 23, 2013

Alexei A. Starobinsky (Landau Inst and RESCEU)
Present status of viable cosmological models in f(R) gravity
Jan 23, 2013

Cristina Manolache (Imperial College London)
Comparing Gromov-Witten-like invariants
Jan 23, 2013

Rik Williams (Carnegie Observatories)
Galaxy Assembly in the Thermal Era
Jan 24, 2013

Gerard van der Geer (U Amsterdam)
Hurwitz spaces and divisors on moduli spaces of curves
Jan 24, 2013

Beth Reid (UC Berkeley)
2D galaxy clustering in SDSS-III BOSS: growth of structure, geometry, and small-scale galaxy motions at z=0.57
Jan 25, 2013

Masao Hayashi (NAOJ)
Star formation activity in and around high-z clusters revealed with Subaru
Jan 28, 2013

Nadav Drukker (King's College London)
The quark-antiquark potential in N=4 SYM from an open spin-chain
Jan 29, 2013

Kendall Mahn (TRIUMF)
Recent results from the T2K long baseline neutrino experiment
Jan 30, 2013

Yoichi Iwasaki (U Tsukuba)
Conformal Theories with IR cutoff
Jan 30, 2013

Pascal Oesch (UC Santa Cruz)
Probing the Dawn of Galaxies at z ~ 9 − 12
Jan 31, 2013

Annalisa Pillepich (UC Santa Cruz)
From the initial conditions of the Universe to our own Milky Way
Feb 04, 2013

Mark Hartz (York U)
Neutrino Production and Interaction Modeling for Long Baseline Neutrino Experiments
Feb 04, 2013

Artan Sheshmani (Max Planck Inst)
Donaldson-Thomas invariants of 2-dimensional torsion sheaves and modular forms
Feb 04, 2013

Lance Miller (U Oxford)
Measurement of weak lensing shear in CFHTLenS and future surveys
Feb 05, 2013

Aleksey Cherman (U Minnesota)
Large N volume independence and bosonization
Feb 05, 2013

Andrew Wetzel (Yale U)
Galaxy evolution in groups and clusters in a hierarchical Universe
Feb 06, 2013

Teppei Katori (MIT)
Test of Lorentz and CPT violation with Neutrino oscillation experiments
Feb 06, 2013

Jiro Murata (Rikkyo U)
Experimental test of gravitational inverse square law at short range
Feb 06, 2013

Sergei Blinnikov (ITEP)
Building a cosmological distance scale based on type IIn supernovae
Feb 07, 2013

Alexey Bondal (Kavli IPMU)
Categorical approach to discrete harmonic analysis
Feb 07, 2013

Hidemasa Oda (Kavli IPMU)
Triangulated Categories of Matrix Factorizations for Elliptic Singularities
Feb 12, 2013

Tatsu Takeuchi (Virginia Tech)
Analytical Approximation to the Neutrino Oscillation Probabilities at large θ_{13}
Feb 13, 2013

Jay Armas (U Bern)
(Electro)elasticity from Gravity
Feb 15, 2013

Douglas Scott (UBC)
The standard Cosmological Model
Feb 18, 2013

Takeshi Saito (U Tokyo)
Wild Ramification and the Cotangent Bundle
Feb 20, 2013

Chiaki Hikage (Nagoya U)
Towards a precision cosmology with CMB and galaxy survey data
Feb 21, 2013

Omar G. Benvenuto (U La Plata)
The evolution of low mass, close binary systems leading to the formation of "black widow" systems
Feb 26, 2013

Jamie Tattersall (U Bonn)
How low can SUSY go? Monojets, matching and compressed spectra
Feb 27, 2013

Takahiro Nishimichi (Kavli IPMU)
Modeling the nonlinear growth of large scale structure with perturbation theories and N-body simulations: implications to on-going and future surveys
Feb 27, 2013

Elena Sorokina (U Sternberg)
Expansion opacity for type Ia supernovae: How to survive when you need to use more than 10 million spectral lines
Feb 28, 2013

Changzheng Li (Kavli IPMU)
Integrable systems and toric degenerations
Feb 28, 2013

Jason Evans (U Minnesota)
The Lightest Higgs Boson Mass in the MSSM with Strongly Coupled Spectators
Mar 01, 2013

Kiyonori Gomi (Shinshu U)
Mickelsson's twisted K-theory invariant and its generalization
Mar 05, 2013

James Mullaney (U Durham)
The coevolution between black hole and galaxy growth over the past 11 billion years
Mar 06, 2013

Marcin Sawicki (Saint Mary's U)
The Life and Death of Galaxies at Cosmic High Noon
Mar 07, 2013

Mohammad Sami (Jamia Millia Islamia)
Dark energy and beyond
Mar 07, 2013

Shufang Su (U Arizona)
Low-Mass Higgs Bosons in the NMSSM and Their LHC Implications
Mar 08, 2013

Rafael Lang (Purdue U)
The Direct Search for Dark Matter
Mar 08, 2013

Gil Paz (Wayne State U)
The charge radius of the proton
Mar 11, 2013

Liucheng Wang (Zhejiang Inst Modern Phys)
Revisit to Non-decoupling MSSM
Mar 11, 2013

Ran Huo (U Chicago)
Some Implications of Higgs Diphoton Excess
Mar 12, 2013

Michele Redi (CERN)
Axion-Higgs Unification
Mar 13, 2013

Michihisa Takeuchi (King's College London)
Top Quarks and Jet Substructure at the LHC
Mar 14, 2013

Charles Siegel (Kavli IPMU)
Cyclic Covers, Pryms and Moduli
Mar 14, 2013

Gautam Bhattacharyya (Saha Inst Nucl Phys)
Geometrical CP violation and nonstandard Higgs decays
Mar 15, 2013

Wiphu Rujopakarn (U Arizona)
Toward an Extinction-Free Picture of Galaxy Evolution
Mar 19, 2013

Simone Giacomelli (Scuola Normale Superiore & INFN Pisa)
Singular points and confinement in SQCD
Mar 19, 2013

Ariel Goobar (Oskar Klein Centre, Stockholm U)
Cosmology with Type Ia SN after the Nobel prize: level-up or game-over?
Mar 27, 2013

Ivan Chi-Ho Ip (Kavli IPMU)
Universal R-operator for split real quantum groups
Mar 28, 2013

9 Conferences

JFY2012

Kavli IPMU Scientific Symposium
May 9, 2012

Workshop “Science Opportunities with Wide-Field Imaging and Spectroscopic Surveys”
June 1, 2012

Workshop “Geometry and Physics of the Landau Ginzburg Model”
June 25 - 29, 2012

Open Meeting for Hyper-Kamiokande Project
August 21 - 23, 2012

Workshop “Homological Projective Duality and Quantum Gauge Theory”
November 12 - 16, 2012

Workshop “Supernovae, Dark Energy and Cosmology”
November 20 - 21, 2012

Focus Week “Supernovae Near and Far”
December 12 – 14, 2012

Second Open Meeting for Hyper-Kamiokande Project
January 14 - 15, 2013

Kavli IPMU-FMSP Tutorial Workshop “Geometry and Mathematical Physics”
January 22 - 25, 2013

Focus Week “Gravity and Lorentz Violations”
February 18 - 22, 2013

Workshop “Exceptional Structures in Geometry and Conformal Field Theory”
March 4 - 8, 2013

10 Conference Talks

(Including seminars given outside Kavli IPMU)

JFY2012

Geometry and Physics Seminar
(2012.04.02, U Michigan)
Changzheng Li
Classical aspects of quantum cohomology of flag varieties

Interacting Galaxies and Binary Quasars: A Cosmic Rendezvous
(2012.04.02 - 04.05, Trieste)
John Silverman
Enhanced AGN activity in zCOSMOS Galaxy Pairs

Theory Seminar at Vienna Tech
(2012.04.03, Vienna)
Johanna Knapp
New Calabi-Yau manifolds and their relation to non-abelian gauged linear sigma models

Progress in Quantum Field Theory and String Theory
(2012.04.03 - 04.07, Osaka City U, Osaka)
Shigeki Sugimoto
On S-duality in non-SUSY gauge theory

Symposium of the Sino-German GDT Cooperation
(2012.04.08 - 04.12, Tuebingen, Germany)
Jing Liu
What you need to design a detector: Principles of Field Calculations and Pulse

Symposium of the Sino-German GDT Cooperation
(2012.04.08 - 04.12, Tuebingen, Germany)
Jing Liu
Measurement of Neutron Interactions With an 18-Fold Segmented True Coax

Algebra Seminar
(2012.04.11, Virginia Tech)
Changzheng Li
Quantum Pieri rules for tautological subbundles over symplectic Grassmannians

Integrability in topological field theories
(2012.04.16 - 04.20, HIM, Bon, Germany)
Todor Milanov
Period integrals and twisted representations of vertex algebras

Singularity theory and integrable systems
(2012.04.22 - 04.28, Oberwolfach, Germany)
Todor Milanov
Orbifold projective lines and integrable hierarchies

Birational and Affine Geometry
(2012.04.23 - 04.27, Steklov Math Inst, Moscow)
Sergey Galkin
Minifolds

Conformal Nature of the Universe
(2012.05.09 - 05.12, Perimeter Inst, Canada)
Shinji Mukohyama
Cosmology and GR limit of Horava-Lifshitz gravity

Perspectives in Representation Theory, (in honor of Prof. Igor Frenkel's 60th birthday)
(2012.05.12 - 05.17, Yale U, Connecticut)
Toshiyuki Kobayashi
Geometric Analysis on Minimal Representations

Astronomical Data Analysis VII
(2012.05.14 - 05.18, IESC, Cargese, France)
Masahiro Takada
Weak lensing: Gaussianity and non-Gaussianity

Seminar at Hiroshima U
(2012.05.16, Hiroshima, Japan)
Shinji Mukohyama
Nonlinear Massive Gravity and Cosmology

15th Conference on Representation Theory of Algebraic Groups and Quantum Groups
(2012.05.19 - 05.22, Nagano, Japan)
Katsuyuki Naoi
Classical limits of minimal affinizations and generalized Demazure modules

Seminar at IAP
(2012.05.21, Paris)
Shinji Mukohyama
Cosmology and GR limit of Horava-Lifshitz gravity

First Stars IV - From Hayashi to the Future -
(2012.05.21 - 05.25, Kyoto)
Ken'ichi Nomoto
First Supernovae & Gamma Ray Bursts

Seminar at Tokyo Metropolitan U
(2012.05.23, Tokyo)
Shigeki Matsumoto
Phenomenology of the Little Higgs Model

Seminar at Inst for the Early Universe
(2012.05.24, Seoul)
Masahiro Takada
Information content in weak lensing

Seminar at IAP
(2012.05.25, Paris)
Shinji Mukohyama
Nonlinear Massive Gravity and Cosmology

Blois 2012
(2012.06.01, Blois, France)
Hitoshi Murayama
Highlights and Perspectives

Applications of Gauge-Gravity Duality
(2012.06.03 - 06.07, Technion, Haifa, Israel)
Shigeki Sugimoto
On S-duality in non-SUSY gauge theory

Singularities of differential equations in algebraic geometry
(2012.06.04 - 06.08, Luminy, France)
Todor Milanov
Integrable hierarchies for hypersurface singularities

CompStar: The Physics and Astrophysics of Compact Stars
(2012.06.04 - 06.08, Tahiti)
Ken'ichi Nomoto
Compact Star - Progenitor Connection

Seminar at MPI for Gravitational Physics
(2012.06.05, Potsudam)
Marcus Werner
Optical geometry and gravitational lensing

Arithmetic Geometry week in Tokyo
(2012.06.06, U Tokyo, Japan)
Tomoyuki Abe
Langlands program for p-adic coefficients and the product formula for epsilon factor

NEUTRINO 2012
(2012.06.07, Kyoto Tersra, Japan)
Hitoshi Murayama
Neutrinos maybe our mother

QUARKS-2012
(2012.06.10, Yaroslavl, Russia)
Shinji Mukohyama
Nonlinear massive gravity and Cosmology

Holography: Application to Technicolor, Condensed matter and Hadrons
(2012.06.12, INR RAS, Moscow)
Shinji Mukohyama
A holographic dual of Bjorken Flow

The Evolution of Massive Stars and Progenitors of Gamma-Ray Bursts
(2012.06.19 - 07.01, Aspen Center for Physics, USA)
Ken'ichi Nomoto
Progenitor of Type IIb supernova 2011dh

Seminar at Tokyo Metropolitan U
(2012.06.20, Tokyo)
Shigeki Sugimoto
QCD and String Theory

Seminar
(2012.06.22, Kyoto U)
Tomoyuki Abe
On arithmetic D-modules and Langlands correspondences on function fields for p-adic coefficient theory

Conference in honor of Souriau's 90th birthday
(2012.06.25 - 06.29, Aix-en-Provence, France)
Toshiyuki Kobayashi
Geometric Quantization of Minimal Nilpotent Orbits

Seminar at U Cambridge
(2012.06.25, DAMTP, Cambridge)
Shinji Mukohyama
Nonlinear massive gravity and Cosmology

Black Holes by the Black Sea
(2012.06.25 - 06.29, Koç U, Istanbul)
Malte Schramm
Unveiling a population of galaxies harboring low-mass black holes with X-rays

IAP-Subaru Joint Conference: Stellar Populations Across Cosmic Time
(2012.06.25 - 06.29, IAP, Paris)
John Silverman
Tracing the distribution of star-forming galaxies at z~1.5 in COSMOS with Subaru/FMOS

IAP-Subaru Joint Conference: Stellar Populations Across Cosmic Time
(2012.06.25 - 06.29, IAP, Paris)
Masayuki Tanaka
Quiescent early-type galaxies in groups and clusters at z > 1.5

Seminar at Nagoya U
(2012.06.28 - 06.29, Nagoya, Japan)
Shigeki Matsumoto
Wino Dark Matter and Its Phenomenology

SPIE Conference "Astronomical Telescopes + Instrumentation"
(2012.07.02, Amsterdam)
Hajime Sugai
Prime Focus Spectrograph - Subaru's future -

SPIE Conference "Astronomical Telescopes + Instrumentation"
(2012.07.02, Amsterdam)
Naoyuki Tamura
Subaru FMOS now and future

INT 12-2A Program "Core-Collapse Supernovae"
(2012.07.02 - 07.20, U Washington, Seattle)
Ken'ichi Nomoto
Progenitor's Evolution and Explosion of Type IIb supernova 2011dh in M51

The Thirteenth Marcel Grossmann Meeting
(2012.07.06, Stockholm U, Stockholm)
Shinji Mukohyama
Modified Gravity

CERN Theory Inst 2012 on String Phenomenology
(2012.07.09 - 07.20, CERN, Geneva)
Taizan Watari
A Note on Kahler Potential of Charged Matter in F-theory

Seminar at Komaba
(2012.07.10, U Tokyo)
Marcus Werner
Topology and Lefschetz fixed point theory in gravitational lensing

Cosmology Summer School
(2012.07.19 - 07.21, Beijin Normal U, Beijing)
Masamune Oguri
Lecture Series: Applications of Gravitational Lensing in Astrophysics and Cosmology

WISH Science Workshop
(2012.07.19 - 07.20, NAOJ, Tokyo)
Masayuki Tanaka
Synergy between WISH and HSC for galaxy studies

Pan Asian Number Theory Conference
(2012.07.24, IISER Pune, India)
Tomoyuki Abe
Langlands program for p-adic coefficients and petits camarades conjecture

Nonlinear Massive Gravity Theory and Its Observational Test
(2012.07.23 - 08.09, YITP, Kyoto)
Emir Gumrukcuoglu
Fate of homogeneous and isotropic solutions in massive gravity

Seminar at Waseda U
(2012.07.27, Tokyo)
Marcus Werner
Optical geometry and gravitational lensing

Summer School
(2012.08.02 - 08.07, Fuji-Yoshida, Japan)
Shigeki Matsumoto
Current Status of Dark Matter Studies

XII International Symposium on Nuclei in the Cosmos
(2012.08.05 - 08.12, Cairns, Australia)
Ken'ichi Nomoto
Nucleosynthesis in Hypernovae and Other Unusual Supernovae, compared with the Abundance Patterns of Extremely Metal-Poor Stars

ICPS 2012
(2012.08.05, Utrecht, Netherlands)
Hitoshi Murayama
Big World of Little Neutrinos

Accelerator & Detector Studies at ILC
(2012.08.07, KEK, Tsukuba, Japan)
Shigeki Matsumoto
New Physics in light of 125 GeV Higgs

SUSY 2012
(2012.08.13 - 08.18, Peking U, Beijing)
John Fotis Kehayias
Three Generations From a Non-Anomalous Discrete R-Symmetry

SUSY 2012
(2012.08.13 - 08.18, Peking U, Beijing)
Sourav K. Mandal
Prospects for Measuring the Stop Mixing Angle at the LHC

SUSY 2012
(2012.08. 18, Peking U, Beijing)
Hitoshi Murayama
Physics at the frontiers

Seminar at KIAS
(2012.08.16, Korea Inst for Advanced Study, Seoul)
Changzheng Li
On certain K-theoretic Gromov-Witten invariants of homogeneous varieties

Summer Inst
(2012.08.18 - 08.24, Sun Moor Lake, Taiwan)
Shigeki Matsumoto
Phenomenology of the Wino Dark Matter

The 29th International Colloquim on Group Theoretical Methods in Physics
(2012.08.20 - 08.26, Chern Inst Math, Tianjin, China)
Ivan Chi-Ho Ip
Positive Representations of Split Real Quantum Groups

The 29th International Colloquim on Group Theoretical Methods in Physics
(2012.08.20 - 08.26, Chern Inst Math, Tianjin, China)
Shigeki Sugimoto
On S-duality in non-SUSY gauge theory

Mirror Symmetry and Related Topics
(2012.08.20 - 08.24, Kunming U of Science and Tech, Kunming, China)
Changzheng Li
Space of lines in homogeneous varieties

IAU 28th General Assembly, SpS2
(2012.08.20, Beijing)
Masayuki Tanaka
Quiescent early-type galaxies in z > 1.5 groups

Seminar at ITU
(2012.08.24, Istanbul Technical U, Istanbul)
Emir Gumrukcuoglu
General Relativity limit of Horava-Lifshitz gravity

Astronomy department seminar at AlbaNova University Center
(2012.08.29, Stockholm U, Stockholm)
Takashi Moriya
Superluminous Supernovae

SKKU Symposium on Astrophysics and Cosmology: from Particle to Universe
(2012.08.30 - 09.01, Sungkyunkwan U, Korea)
Shigeki Matsumoto
Phenomenology of Pure Gravity Mediation

SKKU Symposium on Astrophysics and Cosmology: From Particle to Universe
(2012.08.30 - 09.01, Sungkyunkwan U, Korea)
Shinji Mukohyama
Alternative gravity theories

Workshop on CSM and Type Ia Supernovae
(2012.08.31, Stockholm U, Stockholm)
Keiichi Maeda
Asymmetries and Reddening of Supernovae

Seminar
(2012.09.02 - 09.09, The Oskar Klein Centre - AlbaNova, Stockholm U)
Melina Bersten
Hydrodynamical models for Supernova Type IIb 2011dh

Chubu Summer School (Lecture Series)
(2012.09.03 - 09.06, Tokai U, Yamanashi, Japan)
Shigeki Sugimoto
String theory and QCD

Seminar at MSGSU
(2012.09.06, Mimar Sinan Fine Arts U, Istanbul)
Emir Gumrukcuoglu
Cosmology in nonlinear massive gravity

MPA/ESO/MPE/Excellence Cluster Universe Conference on Supernovae Illuminating the Universe: from Individuals to Populations
(2012.09.10 - 09.14, Technical U, Garching, Germany)
Ken'ichi Nomoto
Binary Stellar Evolution Leading to SN Explosions

MPA/ESO/MPE/Excellence Cluster Universe Conference on Supernovae Illuminating the Universe: from Individuals to Populations
(2012.09.10 - 09.14, Technical U, Garching, Germany)
Keiichi Maeda
Modeling non-thermal emissions from supernovae

The Interaction of Geometry and Representation Theory: Exploring New Frontiers (in honor of Michael Eastwood's 60th birthday)
(2012.09.10 - 10.14, ESI, Vienna)
Toshiyuki Kobayashi
Natural Differential Operators in Parabolic Geometry and Branching Laws

COSMO 2012
(2012.09.10 - 09.14, KITPC, Beijing)
Emir Gumrukcuoglu
Non-linear instability of homogeneous and isotropic solutions in massive gravity

COSMO 2012
(2012.09.10 - 09.14, Beijing)
Shinji Mukohyama
Universal upper limit on inflation energy scale from cosmic magnetic field

Relation of String Theory to Gauge Theories and Moduli Problems of Branes
(2012.09.10 - 09.14, Steklov Math Inst, Moscow)
Taizan Watari
Particle Physics and Geometric Data for String Compactification

Growing-up at High Redshift: from Proto-Clusters to Galaxy Clusters
(2012.09.10 - 09.13, European Space Agency, Madrid)
Masayuki Tanaka
Quiescent early-type galaxies in groups and clusters at z > 1.5

Seminar
(2012.09.11, Royal Observatory of Edinburgh, Scotland)
Alexie Leauthaud
Constraining galaxy formation with weak gravitational lensing

JPS meeting
(2012.09.11, Kyoto Sangyo U, Kyoto)
Shigeki Matsumoto
Collider Signals of the Pure Gravity Mediation Model

JPS meeting
(2012.09.12, Kyoto Sangyo U, Kyoto)
Hitoshi Murayama
Physics prospects of Higgs boson

Seminar
(2012.09.16 - 09.29, The Observatory of Geneva)
Melina Bersten
Light Curves of SN II-Plateau

Annual Meeting of the Argentine Astronomical Association
(2012.09.17 - 09.21, Mar del Plata, Argentina)
Gaston Folatelli
Supernovae and Cosmology

Seminar at Astrophysics Department of CEA-Saclay
(2012.09.18, Saclay, France)
Ken'ichi Nomoto
Super-Chandrasekhar-Mass Modeling of SN2009dc

Annual Meeting of Astronomical Society of Japan
(2012.09.19 - 09.21, Oita U, Oita, Japan)
Masayuki Tanaka
Deep near-IR spectroscopy of a forming cluster at z=2.16

Cosmology and Astroparticle Physics
(2012.09.20, KITPC, Beijing)
Shinji Mukohyama
Nonlinear Massive Gravity and Cosmology

Cosmology and Astroparticle Physics
(2012.09.20, KITPC, Beijing)
Shinji Mukohyama
Cosmology and GR limit of Horava-Lifshitz gravity

International Symposium on Neutrino Physics and Beyond
(2012.09.23 - 09.26, Shenzhen, China)
Jing Liu
The XMASS 800 kg Experiment

Seminar at Tokyo Tech
(2012.09.25, Tokyo)
Emir Gumrukcuoglu
Cosmology in nonlinear massive gravity

New Challenges for String Phenomenology
(2012.09.26 - 09.28, U Autonoma de Madrid, Madrid)
Taizan Watari
Challenges for String phenomenology after the Revolution in the 90s

Science with HSC Survey
(2012.09.26 - 09.28, NAOJ, Tokyo)
Masamune Oguri
HSC survey and gravitational lensing

Science with HSC Survey
(2012.09.26 - 09.28, NAOJ, Tokyo)
Masayuki Tanaka
Galaxy studies at z<2 with HSC

Large Aperture Millimeter/ Submillimeter Telescopes in the ALMA era
(2012.09.29, NAOJ, Tokyo)
Masamune Oguri
Applications of gravitationally lensed submm galaxies

Japanese-German Symposium
(2012.10.01 - 10.03, Kanazawa U, Kanazawa, Japan)
Shigeki Matsumoto
Pure Gravity Mediation model of SUSY breaking

Seminar at U Amsterdam
(2012.10.02, Amsterdam)
Shigeki Sugimoto
On S-duality in non-SUSY gauge theory

Seminar at Perimeter Institute
(2012.10.02, Waterloo, Canada)
Emir Gumrukcuoglu
Homogeneous and Isotropic Universe from Nonlinear Massive Gravity

Seminar at McGill U
(2012.10.04, Montreal)
Emir Gumrukcuoglu
Fate of cosmological solutions in massive gravity

Seminar at YITP
(2012.10.04, Kyoto U, Kyoto)
Keiichi Maeda
Non-thermal emission from extragalactic supernovae

Hong Kong Geometry Colloquium
(2012.10.06 , HKUST, Hong Kong)
Todor Milanov
Higher genus reconstruction in Gromov-Witten theory

Xth Quark Confinement and the Hadron Spectrum
(2012.10.08 - 10.12, TUM, Garching, Germany)
Shigeki Sugimoto
Holographic QCD -Status and perspectives for the future-

Seminar at U Pennsylvania
(2012.10.08, Philadelphia)
Emir Gumrukcuoglu
Homogeneous and isotropic universe from nonlinear massive gravity

Semianr at Ludwig Maximilians U
(2012.10.11, Munchen)
Shigeki Sugimoto
On S-duality in non-SUSY gauge theory

Seminar at KICP
(2012.10.12, Chicago)
Emir Gumrukcuoglu
Fate of cosmological solutions in massive gravity

SNSNR12
(2012.10.15 - 10.17, NAOJ, Tokyo)
Keiichi Maeda
Extragalactic supernovae and Links to Supernova Remnants

Colloquium Lorrain
(2012.10.16, U Lorraine - Metz, France,)
Toshiyuki Kobayashi
Spectrum on locally symmetric spaces

Seminar at CCPP
(2012.10.17, New York U, New York)
Emir Gumrukcuoglu
Homogeneous and isotropic universe from nonlinear massive gravity

Subaru-GLAO Science Workshop
(2012.10.17 - 10.18, Hilo, Hawaii)
Masayuki Tanaka
Galaxy science with GLAO

Seminar at U Minnesota
(2012.10.18, FTPI, Minneapolis)
Emir Gumrukcuoglu
Homogeneous and isotropic universe from nonlinear massive gravity

Cosmology with Small scales workshop
(2012.10.22, Stanford)
Surhud More
The halo-matter correlation function: results from simulation and dependence on resolution

Harmonic Analysis, Operator Algebras and Representations
(2012.10.22 - 10.26, CIRM, Luminy, France)
Toshiyuki Kobayashi
Finite Multiplicity Theorems and Real Spherical Varieties

Seminar at LeCosPA
(2012.10.23, National Taiwan U, Taipei)
Shinji Mukohyama
Nonlinear Massive Gravity and Cosmology

Seminar at Komaba
(2012.10.24, U Tokyo)
Shigeki Sugimoto
S-duality and Confinement in non-SUSY gauge theory

Colloquium at Osaka City U
(2012.10.24 ,Osaka)
Changzheng Li
Quantum Pieri rules for complex/symplectic Grassmannians

AEPSHEP 2012
(2012.10.25 - 10.26, THE LUIGANS, Japan)
Hitoshi Murayama
Cosmology, astro-particle physics and dark matter

The 2012 IEEE Nuclear Science Symposium
(2012.10.29, Anaheim, USA)
Hitoshi Murayama
Physics of the Linear Colliders

Seminar at Inst Astro Andalucia
(2012.10.30, Granada)
Melina Bersten
Hydrodynamical models for Supernova Type IIb 2011dh

Seminar at INPA Journal Club (LBNL)
(2012.11.01, Berkeley, USA)
Takashi Moriya
Light Curve Modeling of Superluminous Supernovae

p-adic cohomology and its applications to arithmetic geometry
(2012.11.02, Tohoku U, Sendai, Japan)
Tomoyuki Abe
Frobenius structures in the theory of arithmetic D-modules

Workshop Analyse Harmonique - WAH !
(2012.11.02, Reims, France)
Toshiyuki Kobayashi
Global Geometry and Analysis on Locally Homogeneous Spaces
1. (global shape) Is a locally homogeneous space closed?

Workshop Analyse Harmonique - WAH !
(2012.11.02, Reims, France)
Toshiyuki Kobayashi
Global Geometry and Analysis on Locally Homogeneous Spaces
2. (spectral analysis) Does spectrum of the Laplacian vary when we deform the geometric structure?

CST & MISC Joint Symposium on Particle Physics
(2012.11.02 - 11.03, Kyoto Sangyo U, Kyoto)
Shigeki Matsumoto
Current status of dark matter phenomenology

Tsinghua Transient Workshop 2012
(2012.11.05 - 11.09, Tsinghua U, Beijing)
Keiichi Maeda
Supernova Explosion and Nucleosynthesis

Lecture series at U Tokyo
(2012.11.06 - 11.08, Tokyo)
Shigeki Sugimoto
Superstring theory and QCD

Seminar at Rikkyo U
(2012.11.07, Tokyo)
Ivan Chi-Ho Ip
Positive Representations of Split Real Quantum Groups

Series of lectures at Kobe U
(2012.11.07 - 11.09, Kobe, Japan)
Shigeki Matsumoto
Dark matter phenomenology

Axion Cosmophysics
(2012.11.07, KEK, Tsukuba, Japan)
Shinji Mukohyama
Quantum entanglement and black hole entropy

Seminar at Kobe U
(2012.11.09, Kobe, Japan)
Shigeki Matsumoto
A dark matter candidate in light of 125 GeV higgs

Seminar at Kochi U
(2012.11.10, Kochi, Japan)
Charles Siegel
The geometry of theta functions and the Schottky problem

RESCEU Symposium on General Relativity and Gravitation (JGRG22)
(2012.11.12 - 11.16, U Tokyo, Tokyo)
Masahiro Takada
SuMIRe project: Hyper Suprime-Cam (HSC) and Prime Focus Spectrograph (PFS)

RESCEU Symposium on General Relativity and Gravitation (JGRG22)
(2012.11.12 - 11.16, U Tokyo, Tokyo)
Shinji Mukohyama
Nonlinear massive gravity and Cosmology

Hadron Collider Physics Symposium 2012
(2012.11.12 - 11.16, Kyoto U, Kyoto)
Sourav K. Mandal
Top Polarization from Boosted Jet Substructure

Seminaire de Geometrie Arithmetique in IHES
(2012.11.14, IHES, Bures-sur-Yvette, France)
Tomoyuki Abe
Theory of weights in arithmetic D-modules

Korea-Japan Collaboration Workshop
(2012.11.15 - 11.16, Seoul National U, Seoul)
Masayuki Tanaka
X-ray galaxy groups at high redshifts

Seminar
(2012.11.19, Strasbourg U, Strasbourg, France)
Tomoyuki Abe
Theory of weights in arithmetic D-modules

ALMA Users' Meeting
(2012.11.20 - 11.22, NAOJ, Tokyo)
Tomoki Saito
Probing the initial dust formation in Ly-alpha blobs: feasibility study

Supernovae, Dark Energy and Cosmology
(2012.11.20 - 11.21, Kavli IPMU, Kashiwa, Japan)
Masamune Oguri
Measuring the Acceleration of the Universe with Strong Lens Statistics

Supernovae, Dark Energy and Cosmology
(2012.11.20 - 11.21, Kavli IPMU, Kashiwa, Japan)
Keiichi Maeda
Origin of the Diversity of Type Ia Supernovae

Seminar at Tohoku U
(2012.11.22, Sendai, Japan)
Tatsu Takeuchi
Some Mutant Forms of Quantum Mechanics

Seminar at U Tokyo
(2012.11.26, Tokyo)
Shigeki Sugimoto
On S-duality in non-SUSY gauge theory

Observational Cosmology Workshop
(2012.11.27 - 11.29, U Tokyo, Tokyo)
Masahiro Takada
Cosmology with imaging and spectroscopic galaxy surveys

Seminar at KEK
(2012.11.28, Tsukuba, Japan)
Shigeki Sugimoto
S-duality and confinement in non-SUSY gauge theory

Seminar at Hokkaido U
(2012.11.30, Sapporo, Japan)
Shigeki Matsumoto
Detecting 2.7 TeV wino LSP at gamma-ray observations

Seminar
(2012.12.02, U Portsmouth, England)
Alexie Leauthaud
Constraining galaxy formation with weak gravitational lensing

Seminar at RESCEU
(2012.12.03, U Tokyo)
John Fotis Kehayias
Quantum Instability of the Emergent Univers

Seminar
(2012.12.03, ISSP, U Tokyo)
Rene Meyer
Holographic Models of the Fractional Quantum Hall Effect

Ringberg AGN workshop
(2012.12.03 - 12.05, Ringberg Castle, Germany)
John Silverman
AGN environments from LSS down to the host bulge

Symposium on Representation Theory 2012
(2012.12.04 - 12.07, Kagoshima, Japan)
Toshiyuki Kobayashi
Natural Differential Operators in Parabolic Geometry and Branching Problems

Colloquium
(2012.12.05, Harish-Chandra Research Inst, Allahabad, India)
Surhud More
Galaxy-Dark Matter Connection: A cosmological perspective

Seminar
(2012.12.07, YITP, Kyoto U)
Rene Meyer
Holographic Models of the Fractional Quantum Hall Effect

SDSS-III BOSS Collaboration Meeting
(2012.12.10 - 12.12, Carnegie Mellon U, Pittsuburgh)
Masamune Oguri
Searching for gravitationally lensed quasars in BOSS

Subaru Autumn School
(2012.12.11, NAOJ, Tokyo)
Naoyuki Tamura
An overview of Subaru Fiber Multi-Object Spectrograph (FMOS)

Seminar
(2012.12.12, IUCAA, Pune, India)
Surhud More
Cosmological constraints from galaxy surveys

Spectral and Scattering Theory and Related Topics
(2012.12.12 - 12.14, RIMS, Kyoto)
Shigeki Sugimoto
Analysis of hadron spectrum via string theory

Kavli IPMU Focus Week for Supernovae Near and Far
(2012.12.12 - 12.14, U Tokyo, Kashiwa, Japan)
Keiichi Maeda
Luminous SN IIn 2010jl

Kavli IPMU Focus Week for Supernovae Near and Far
(2012.12.12 - 12.14, U Tokyo, Kashiwa, Japan)
Melina Bersten
Light Curve modeling of Stripped Envelope SNe

Kavli IPMU Focus Week for Supernovae Near and Far
(2012.12.12 - 12.14, U Tokyo, Kashiwa, Japan)
Ken'ichi Nomoto
Closing Remarks

Miami 2012, Topical Conference on Elementary Particles, Astrophysics, and Cosmology
(2012.12.13 - 12.20, Fort Lauderdale, Florida)
Tatsu Takeuchi
Some Mutant Forms of Quantum Mechanics

Harmonic Analysis Seminar
(2012.12.14, Charles U, Prague, Czech)
Toshiyuki Kobayashi
Finite Multiplicity Theorems and Real Spherical Varieties

Colloquium
(2012.12.14, NCRA, Pune, India)
Surhud More
The structure of Milky Way dwarf spheroidals

Supermassive Black Holes in the Universe: The Era of the HSC Surveys
(2012.12.18 - 12.20, Ehime U, Ehime, Japan)
Masamune Oguri
Host dark halo masses of quasars

Supermassive Black Holes in the Universe: The Era of the HSC Surveys
(2012.12.18 - 12.20, Ehime U, Ehime, Japan)
Masayuki Tanaka
Photo-z's for AGNs

Seminar at KEK
(2012.12.18, Tsukuba, Japan)
Satyanarayan Mukhopadhyay
Effective couplings of the Higgs boson in the light of recent LHC and Tevatron data

Conference on Astronomical surveys
(2012.12.21, TIFR, Mumbai, India)
Surhud More
Cosmological constraints from galaxy surveys

Japan/Thai workshop in cosmology
(2012.12.27, Pattaya, Thailand)
Shinji Mukohyama
Nonlinear massive gravity and Cosmology

Seminar at the Indian Institute of Astrophysics
(2013.01.02, Bangalore, India)
Ken'ichi Nomoto
Progenitors of Type Ia Supernovae

Seminar at RESCEU
(2013.01.07, U Tokyo)
Emir Gumrukcuoglu
Cosmology in massive gravity

IAU Symposium 296: Supernova Environmental Impacts
(2013.01.07 - 01.11, Raichak, India)
Ken'ichi Nomoto
Recent Developments in Supernova Models

IAU Symposium 296: Supernova Environmental Impacts
(2013.01.07 - 01.11, Raichak, India)
Takashi Moriya
Light Curve Modeling of Superluminous Supernovae

IAU Symposium 296: Supernova Environmental Impacts
(2013.01.07 - 01.13, Raichak, India)
Keiichi Maeda
Supernova Optical Observations and Theory

Algebraische Geometrie Seminar
(2013.01.09, Humboldt U of Berlin, Berlin)
Charles Siegel
The Schottky Problem

HSC-Euclid Science Workshop
(2013.01.10, NAOJ, Tokyo)
Masamune Oguri
Cosmology with HSC-Euclid survey

HSC-Euclid Science Workshop
(2013.01.10, NAOJ, Tokyo)
Masayuki Tanaka
Galaxy studies at z < 2 with HSC+Euclid

Seminari Geometria Algebraica
(2013.01.13, U Barcelona, Barcelona)
Charles Siegel
The Schottky Problem

Subaru Users Meeting FY2012
(2013.01.15 - 01.17, NAOJ, Tokyo)
Masamune Oguri
SDSS J1029+2623: A violent cluster merger?

Subaru Users Meeting FY2012
(2013.01.15 - 01.17, NAOJ, Tokyo)
Malte Schramm
High resolution NIR imaging of quasar host galaxies with IRCS/AO188: Probing the MBH-Mbulge relation at z~3

Seminar at Kobe U
(2013.01.16, Kobe, Japan)
Tatsu Takeuchi
Some Mutant Forms of Quantum Mechanics

Seminar at Hokkaido U
(2013.01.18, Sapporo, Japan)
Shigeki Sugimoto
Confinement and Dynamical Symmetry Breaking in non-SUSY Gauge Theory from S-duality in String Theory

Seminar at Hiroshima U
(2013.01.18, Hiroshima, Japan)
Tatsu Takeuchi
Some Mutant Forms of Quantum Mechanics

Seminar at Tokyo Tech
(2013.01.18, Tokyo)
Marcus Werner
An application of de-Sitter geometry to crater statistics

Colloquium at Keio U
(2013.01.21, Tokyo)
Tatsu Takeuchi
Galois Theory for Physicists: Spontaneous Symmetry Breaking and the Solution to the Quinti

Seminar at Rikkyo U
(2013.01.22, Tokyo)
Shigeki Sugimoto
S-duality and confinement in non-SUSY gauge theory

Seminar at Tokyo Tech
(2013.01.23, Tokyo)
Shigeki Sugimoto
S-duality and confinement in non-SUSY gauge theory

Seminar at KEK
(2013.01.29, Tsukuba, Japan)
Tatsu Takeuchi
Some Mutant Forms of Quantum Mechanics

Seminar at Columbia U
(2013.01.30, New York)
Ivan Chi-Ho Ip
Positive Representations of Split Real Quantum Groups

Seminar
(2013.01.31, Max-Planck-Inst for Physics, Munich, Germany)
Rene Meyer
Bottom Up Model of the Fractional Quantum Hall Effect

Lecture Series at Kinki U
(2013.01.31 - 02.01, Osaka)
Shigeki Sugimoto
QCD and string theory

Colloquium at Osaka City U
(2013.02.01, Osaka)
Masahiro Takada
SuMIRe Project - an ultimate cosmology survey with Subaru

Seminar at Ibaraki U
(2013.02.04, Mito, Japan)
Shigeki Sugimoto
S-duality and confinement in non-SUSY gauge theory

Seminar at Chuo U
(2013.02.04 , Tokyo)
Shinji Mukohyama
Nonlinear massive gravity and Cosmology

Seminar
(2013.02.05, U Crete, Heraklion, Greece)
Rene Meyer
A Holographic Model of the Fractional Quantum Hall Effect

Seminar at Yale U
(2013.02.05, Connecticut)
Ivan Chi-Ho Ip
Universal R Operators for Split Real Quantum Groups

Algebraic Geometry Seminar
(2013.02.13, U Warwick, UK)
Charles Siegel
The Schottky Problem

Compast Star Mergers and Electromagnetic Counterparts
(2013.02.14 - 02.15 , YITP, Kyoto U, Kyoto)
Keiichi Maeda
Supernovae and possible neutron star-neutron star merger electromagnetic signatures

2013 American Association for the Advancement of Science (AAAS) Annual Meeting
(2013.02.14 - 02.18, Boston, Massachusetts)
Chang Kee Jung
The Challenging Art of Creating and Catching Human-Made Neutrinos

SJSU colloquium
(2013.02.18 , San Jose, CA, USA)
Todor Milanov
Soliton equations in the topological string model

Mathematical Panorama Lectures in celebration of 125th birthday of Srinivasa Ramanujan
(2013.02.18 - 02.22, Tata Inst, India,)
Toshiyuki Kobayashi
Branching Laws for Infinite Dimensional Representations of Real Reductive Lie Groups
1. Multiplicity-free Theorems. Theory of Visible Actions on Complex Manifolds

Mathematical Panorama Lectures in celebration of 125th birthday of Srinivasa Ramanujan
(2013.02.18 - 02.22, Tata Inst, India,)
Toshiyuki Kobayashi
Branching Laws for Infinite Dimensional Representations of Real Reductive Lie Groups
2. Finite Multiplicity Theorms. Theory of Real Spherical Varieties

Mathematical Panorama Lectures in celebration of 125th birthday of Srinivasa Ramanujan
(2013.02.18 - 02.22, Tata Inst, India,)
Toshiyuki Kobayashi
Branching Laws for Infinite Dimensional Representations of Real Reductive Lie Groups
3. Restriction of Unitary Representations. Theory of Discretely Decomposable Branching Laws

Mathematical Panorama Lectures in celebration of 125th birthday of Srinivasa Ramanujan
(2013.02.18 - 02.22, Tata Inst, India,)
Toshiyuki Kobayashi
Branching Laws for Infinite Dimensional Representations of Real Reductive Lie Groups
4. Restrictions of generalized Verma Modules

Mathematical Panorama Lectures in celebration of 125th birthday of Srinivasa Ramanujan
(2013.02.18 - 02.22, Tata Inst, India,)
Toshiyuki Kobayashi
Branching Laws for Infinite Dimensional Representations of Real Reductive Lie Groups
5. Some Applications of Branching Problems to Geometric Problems

Seminar at Osaka U
(2013.02.19, Osaka)
Tatsu Takeuchi
Some Mutant Forms of Quantum Mechanics

Research seminar Algebraic and Arithmetic Geometry
(2013.02.19, Leibniz U, Hannover)
Charles Siegel
The Schottky Problem

Kavli IPMU focus week on Gravity and Lorentz violations
(2013.02.22 , Kavli IPMU, Kashiwa ,Japan)
Shinji Mukohyama
From configuration to dynamics

Lie Theory Seminar at HKUST
(2013.02.25, Hong Kong U of Sci Tech, Hong Kong)
Ivan Chi-Ho Ip
Positive Representations of Split Real Quantum Groups

Seminar at NCSU
(2013.02.25, Raleigh, NC, USA)
Todor Milanov
The local Eynard–Orantin recursion in singularity theory

J-PARC International Advisory Committee (IAC) meeting
(2013.02.25 - 2013.02.26, Tokai, Japan)
Chang Kee Jung
Neutrino Physics at J-PARC: T2K

Seminar at Geneva Observatory
(2013.03.01, Geneva, Switzerland)
Takashi Moriya
Type IIn Supernovae and Explosive Mass Loss of their Progenitors Shortly before their Explosions

Gravitational Wave Astronomy
(2013.03.01 - 03.02, Osaka City U, Osaka)
Keiichi Maeda
A Multi-Frequency View on Supernovae as Gravitational Wave Sources

SPICA/MCS meeting
(2013.03.04 - 03.05, ASIAA, Taipei)
Tomoki Saito
Sort comments on stellar population studies at reionisation era

The 13th HEAPA meeting
(2013.03.04 - 03.06, Kanazawa, Japan)
Keiichi Maeda
Radioactive Decay High Energy Signals from Supernovae and Astro-H

KEK-PH2013
(2013.03.04 - 03.07, KEK, Tsukuba, Japan)
Tatsu Takeuchi
Analytical Approximation of the Neutrino Oscillation Probabilities at large θ_{13}

KEK-PH2013
(2013.03.04 - 03.07, KEK, Tsukuba, Japan)
Shigeki Matsumoto
Detecting Wino Dark Matter at Gamma-ray Observations

Infinite Analysis: Past, Present and Future
(2013.03.04 - 03.09, Kyoto U, Kyoto)
Ivan Chi-Ho Ip
Positive Representations of Split Real Quantum Groups

Seminar at Universidad de Chile
(2013.03.11, Santiago, Chile)
Ken’ichi Nomoto
Progenitors of Type Ia Supernovae

Seminar at Argelander Inst for Astronomy
(2013.03.14, Bonn, Germany)
Takashi Moriya
Interacting Supernovae and Extensive Mass Loss shortly before the Explosions

KEK-IMS Joint Workshop “The Deepening and Development of Quantum Theory”
(2013.03.18 - 03.19, Okazaki, Japan)
Tatsu Takeuchi
Some Mutant Forms of Quantum Mechanics

Workshop on “Elucidation of New Hadrons with a Variety of Flavors”
(2013.03.21 - 03.22, KEK, Tsukuba, Japan)
Takeo Higuchi
Portable DAQ System - POCKET DAQ -

PFS collaboration meeting 2013
(2013.03.25, U Tokyo, Japan)
Hitoshi Murayama
Overview

JPS conference
(2013.03.26 - 03.29 , Hiroshima U, Hiroshima, Japan)
Shigeki Matsumoto
Detecting Wino Dark Matter at Gamma-ray Observations

ngCFHT Workshop
(2013.03.28, Imiloa Astronomy Center of Hawaii)
Hitoshi Murayama
SuMIRe/PFS

11 Visitors

(This list includes principal investigators and affiliate members)

JFY2012

Abdelgadir, Tarig Mahgoub Hassan
KIAS, Mathematics
2012/5/28-6/10

Abouzaid, Mohammed
SUNY, Stony Brook, Mathematics
2012/6/21-6/30

Afshordi, Niayesh
Perimeter Inst, Cosmology
2013/2/17-2/23

Akhlaghi, Mohammad
Tohoku U, Astronomy
2012/9/3-9/5

Akiri, Tarek
Duke U, Neutrino Physics
2013/1/14-1/15

Akiyama, Masayuki
Tohoku U, Astronomy
2013/3/25-3/27

Allcock, Daniel
U Texas, Mathematics
2013/3/3-3/8

Alvarez, Marcelo
CITA, Cosmology
2012/10/21-11/7

Amram, Philippe
LAM, Astronomy
2013/3/23-3/30

Anderson, Joseph
U Chile, Astronomy
2012/12/10-12/21

Armas, Jacome
U Bern, String Theory
2013/2/15-2/19

Armoni, Adi
Swansea U, String Theory
2012/10/4-2013/8/28

Asano, Masaki
U Hamburg, Particle Theory
2012/7/25-8/10

Aso, Kazuhiko
U Tokyo, Math Sci, Mathematics
2012/6/25-6/29

Assef, Roberto
NASA JPL/Caltech, Astronomy
2013/2/10-2/14

Ballard, Matthew
U Vienna, Mathematics
2012/11/11-11/18

Barr, Giles
U Oxford, Particle Theory
2013/1/14-1/15

Barvinsky, Andrei
LPI, Russian Academy of Sciences, Cosmology
2012/11/24-11/28

Basak, Tathagata
Iowa State U, Mathematics
2012/7/16-8/16

Bayer, Arend
U Edinburgh, Mathematics
2013/1/21-1/24

Benincasa, Samantha
McMaster U, Astrophysics
2012/7/11-7/16

Benini, Francesco
SUNY, Stony Brook, High Energy Physics
2012/10/9-10/12

Benvenuto, Omar
National U of La Plata, Astrophysics
2013/2/8-2/28

Berkman, Sophie
U British Columbia, High Energy Physics
2013/1/14-1/15

Bhattacharyya, Gautam
Saha Inst of Nuclear Physics, Particle Theory
2013/2/20-3/22

Blandford, Roger
KIPAC, Cosmology
2012/5/8-5/11

Blas, Diego
CERN, Cosmology
2013/2/17-2/27

Blinnikov, Sergei
ITEP, Astronomy
2013/2/2-2/13

Bodzenta-Skibinska, Agnieszka Maria
U Warsaw, Mathematics
2012/11/4-12/2, 2013/2/3-2/15

Bosch, Jim
Princeton U, Astrophysics
2012/7/22-8/1, 2013/2/19-3/2

Bousso, Raphael
UC Berkeley, Cosmology
2012/6/3-6/6

Brandenberger, Robert
McGill U, Cosmology
2012/12/8-12/13

Braun, Andreas
U Vienna, Particle Theory
2012/6/30-9/29

Braun, David
NASA JPL/Caltech, Astronomy
2013/3/24-3/29

Brauner, Tomas
Bielefeld U, Particle Theory
2013/1/7-1/12

Brini, Andrea
Imperial Coll. London, Mathematical Physics
2012/6/24-7/1

Brümmer, Felix
DESY, Particle Theory
2012/11/26-11/30

Bronner, Christophe
Kyoto U, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Bufano, Filomena
U Andres Bello, Astronomy
2012/12/9-12/21

Bunker, Andrew
U Oxford, Astrophysics
2013/3/31-4/13

Bureau, Martin
U Oxford, Astrophysics
2012/9/12-9/13

Cantiello, Matteo
KITP, Astrophysics
2012/9/4-9/5

Carminati, Giada
UC Irvine, Astrophysics
2013/1/14-1/15

Chan, Kwokwai
CUHK, Mathematics
2012/6/25-6/29

Chang, Chihway
KIPAC, Cosmology
2012/7/30-7/31

Chang, Huai-Liang
HKUST, Mathematics
2012/6/17-6/30

Chang, Hui-Yiing
Vanderbilt U, Cosmology
2012/6/19-8/21

Charles, Francois
LPTHE, Mathematics
2012/5/7-5/19

Cheng, Miranda
Jussieu Mathematics Inst, Mathematics
2013/3/2-3/9

Cherman, Aleksey
FTPI, Particle Theory
2013/2/4-2/8

Chiba, Masashi
Tohoku U, Astronomy
2012/8/13-8/16, 2013/2/24-2/28, 3/25-3/28

Chida, Masataka
Kyoto U, Mathematics
2012/5/21-5/25

Chiodo, Alessandro
U Grenoble, Mathematics
2012/6/25-6/29

Cho, Cheol Hyun
Northwestern U, Mathematics
2012/6/23-7/1

Choi, Koun
Nagoya U, Neutrino Physics
2012/8/21-8/23

Chou, Mei-Yin
ASIAA, Astronomy
2013/3/24-3/29

Chun, Eung
KIAS, Particle Theory
2012/10/8-10/15

Cohen, Judy
Caltech, Astronomy
2013/3/24-3/28

Cooke, Jeff
Swinburne U of Technology, Astrophysics
2012/5/26-5/30

Coupon, Jean
ASIAA, Astronomy
2012/7/9-7/13, 2013/3/24-4/1

Crampton, David
National Research Council Canada, Astronomy
2013/2/24-2/27

Creutzig, Thomas
U Darmstadt, Mathematics
2013/3/31-4/14

Cruz, Maria
Science magazine, Astronomy
2012/5/9-5/10

Cuillandre, Jean-Charles
Observatoire de Paris, Astronomy
2012/5/28-6/5

De Oliveira, Antonio
LNA, Astronomy
2013/3/23-3/31

De Perio, Patrick
U Toronto, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

De Putter, Roland
NASA JPL/Caltech, Astrophysics
2013/3/23-3/30

Decowski, Patrick
U Amsterdam/GRAPPA, Neutrino Physics
2012/9/24-10/3, 2013/3/14-3/24

Dekany, Richard
Caltech, Astronomy
2013/3/25-3/30

Deliu, Dragos
U Vienna, Mathematics
2012/11/11-11/17

Di Lodovico, Francesca
QMUL, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Diemer, Colin
U Vienna, Mathematics
2012/11/4-11/18

Dimitrov, George
U Vienna, Mathematics
2012/11/11-11/17

Drout, Maria
Harvard U, Astronomy
2012/8/19-9/2

Drukker, Nadav
Imperial Coll. London, Particle Theory
2013/1/27-2/12

Duncan, John F
Harvard U, Mathematics
2013/3/4-3/8

Ebisuzaki, Toshikazu
RIKEN, Astrophysics
2012/5/9

Efimov, Alexander
Steklov Math Inst, Mathematics
2012/11/1-11/21

Efremenko, Yuri
U Tennessee, Neutrino Physics
2012/6/26-7/3, 12/4-12/12, 2013/3/17-3/24

Efstathiou, George
KICC, Astronomy
2012/5/8-5/11

Ellis, John
CERN, Particle Theory
2012/7/23-7/25

Ellis, Richard
Caltech, Astronomy
2013/3/24-3/27

Enomoto, Sanshiro
U Washington, Neutrino Physics
2012/9/11-9/26

Esmaili Taklimi, Arman
UNICAMP, Particle Theory
2012/6/10-6/23

Evans, Jason
U Minnesota, Particle Theory
2013/2/27-3/11

Evnin, Oleg
Chulalongkorn U, String Theory
2012/11/19-11/22

Fallest, David
NCSU, Astrophysics
2012/8/2-8/11

Favero, David
U Vienna, Mathematics
2012/11/5-11/18

Fialkov, Anastasia
Tel Aviv U, Cosmology
2012/11/4-11/8

Fisher, Charles
NASA JPL/Caltech, Astronomy
2012/6/30-7/6, 2013/3/24-3/28

Forster, Francisco
U Chile, Astronomy
2012/12/10-12/21

Frebel, Anna
MIT, Astrophysics
2012/5/27-6/4

Freytis, Marat
UC Berkeley, Particle Theory
2012/7/31-8/19

Friedl, Markus
HEPHY, Austrian Academy of Sciences, High Energy Physics
2013/3/4-3/30

Fritzsch, Harald
LMU Munich, Particle Theory
2012/5/14-6/9

Frolov, Andrei
Simon Fraser U, Cosmology
2012/11/19-11/20

Fuchs, Jurgen
Karlstad U, Mathematics
2012/8/6-8/8

Fujikawa, Brian
LBL, Berkeley, Neutrino Physics
2013/3/2-3/21

Fujikawa, Kazuo
RIKEN, Particle Theory
2012/12/19

Fukaya, Kenji
Kyoto U, Mathematics
2012/6/25-6/29, 10/24-10/26

Fukuda, Yoshiyuki
Miyagi U of Education, High Energy Physics
2013/1/14-1/15

Furukawa, Ryo
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Futamase, Toshifumi
Tohoku U, Gravity
2012/6/4

Gaberdiel, Matthias
ETH Zurich, Mathematics
2013/1/14-1/20

Galkin, Sergey
Independent U Moscow, Mathematics
2012/5/1-5/31
Moscow Inst of Physics and Technology, Mathematics
2012/11/11-11/25, 2013/2/25

Gandhi, Poshak
JAXA, Astronomy
2012/12/14

Ganezer, Kenneth
CaliforniaState U, High Energy Physics
2013/1/14-1/15

Garrison, Lehman
Princeton U, Astroparticle Physics
2012/6/3-8/1

George, Matthew
UC Berkeley, Astronomy
2012/6/18-6/22

Giacomelli, Simone
Scuola Normale Superiore di Pisa, Mathematical Physics
2013/2/15-8/1

Gomes, Henrique
UC Davis, Gravity
2013/2/17-2/28

Gomi, Kiyonori
Shinshu U, Mathematics
2013/2/28-3/7

Gonzalez Gaitan, Santiago
U Chile, Astronomy
2012/12/10-12/21

Goobar, Ariel
Stockholm U, Astrophysics
2013/3/23-3/29

Gorbunov, Dmitry
Russian Academy of Science, Astroparticle Physics
2012/11/16-11/25

Goto, Tomotsugu
U Copenhagen, Astronomy
2013/3/24-3/29

Graur, Or
American Museum of Natural History, Astronomy
2012/6/24-8/16

Graves, Genevieve
Princeton U, Astronomy
2013/3/24-3/28

Green, Daniel
IAS, Cosmology
2012/4/2-4/6

Greene, Jenny
Princeton U, Astronomy
2013/3/25-4/1

Gregory, Ruth
Durham U, String Theory
2012/9/23-9/27

Greig, Bradley
U Melbourne, Astrophysics
2012/7/1-8/1

Grojean, Christophe
U Autonoma de Barcelona, Particle Theory
2013/1/21-1/24

Gumplinger, Peter
TRIUMF, High Energy Physics
2013/1/14-1/15

Gunn, James
Princeton U, Astrophysics
2013/3/23-3/29

Hachisu, Izumi
U Tokyo, Astronomy
2012/10/29

Hadley, David
U Warwick, High Energy Physics
2013/1/14-1/15

Haga, Yuto
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23

Haiden, Fabian
U Vienna, Mathematics
2012/11/11-11/17

Halpern-Leistner, Daniel
UC Berkeley, Mathematics
2012/6/24-7/8, 11/12-11/24

Hamuy, Mario
U Chile, Astronomy
2012/12/11-12/21

Hara, Koji
KEK, Particle Theory
2012/10/15

Hartz, Mark
U Toronto, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15, 1/31-2/4

Hashimoto, Yoshitake
Osaka City U, Mathematics
2012/5/26

Hayashi, Kohei
Tohoku U, Astronomy
2012/8/13-8/18, 2013/3/25-3/28

Hayashi, Masao
NAOJ, Astronomy
2013/1/28

Hayato, Yoshinari
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Hazumi, Masashi
KEK, High Energy Physics
2012/8/24, 2013/2/23-2/28

Heckman, Timothy
Johns Hopkins U, Astrophysics
2013/3/24-3/29

Heng, Yuekun
IHEP, High Energy Physics
2013/1/14-1/15

Henning, Brian
UC Berkeley, Particle Theory
2012/7/29-8/19

Higuchi, Takeo
KEK, High Energy Physics
2012/10/3

Hikage, Chiaki
Nagoya U, KMI, Astronomy
2012/6/22-6/24, 2013/2/20-2/22

Hikasa, Ken-ichi
Tohoku U, Particle Theory
2012/10/19-10/20

Hills, James
CaliforniaState U, High Energy Physics
2013/1/14-1/15

Himmel, Alexander
Duke U, High Energy Physics
2013/1/14-1/15

Hinterbichler, Kurt
Perimeter Inst, Cosmology
2012/10/5-10/19

Hirata, Christopher Michael
Caltech, Astronomy
2013/3/24-3/28

Hirota, Seiko
Kyoto U, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Hirschi, Raphael
Keele U, Astronomy
2012/5/17-5/27

Ho, Shirley
Carnegie Mellon U, Cosmology
2012/10/17-10/28

Hong, Hansol
Seoul National U, Mathematics
2012/6/24-6/30

Hoppe, Jens
KTH Royal Inst of Technology, Mathematics
2012/4/5

Horava, Petr
UC Berkeley, String Theory
2013/2/17-2/23

Horiuchi, Shunsaku
Ohio State U, Astroparticle Physics
2012/8/21-8/23

Horja, Richard Paul
U Vienna, Mathematics
2012/11/11-11/17

Hosono, Shinobu
U Tokyo, Math Sci, Mathematical Physics
2012/6/25-6/29

Hsiao, Yu Chi Eric
Carnegie Obs, Astronomy
2012/12/10-12/14

Hu, Wayne
KICP, Cosmology
2012/12/14-12/21

Hua, Zheng
U Kansas, Mathematics
2012/12/12-12/16

Huang, Kunxian
Kyoto U, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Huo, Ran
U Chicago, Cosmology
2013/3/7-3/15

Hut, Piet
IAS, Astrophysics
2012/4/18-4/20

Hwang, DongSeon
Ajou U, Mathematics
2013/1/11-1/14

Ichikawa, Atsuko
Kyoto U, Neutrino Physics
2012/8/21-8/23

Ichikawa, Kohei
Kyoto U, Astronomy
2013/3/24-3/28

Ihl, Matthias
DIAS, String Theory
2012/5/7-6/2

Iijima, Toru
Nagoya U, KMI, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Ikeda, Akishi
U Tokyo, Math Sci, Mathematics
2012/6/25-6/29

Ikeda, Motoyasu
Kyoto U, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Ikeda, Yujiro
J-PARC, High Energy Physics
2012/8/21-8/23

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MPI for Nuclear Physics Heidelberg, Astrophysics
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Iritani, Hiroshi
Kyoto U, Mathematics
2012/6/24-6/28

Irmler, Christian
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2012/6/3-6/20, 2013/3/4-3/30

Ishida, Taku
KEK, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Ishigaki, Miho N
NAOJ, Astronomy
2012/8/12-8/26, 2013/2/7, 3/27-3/28

Ishikawa, Akimasa
Tohoku U, High Energy Physics
2012/6/24-6/28, 7/3-7/7

Ishitsuka, Masaki
Tokyo Tech, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Ishizuka, Yuma
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Isik, Mehmet Umut
U Vienna, Mathematics
2012/11/5-11/18

Itow, Yoshitaka
Nagoya U, Neutrino Physics
2012/8/21-8/23

Iwasaki, Yoichi
KEK, Particle Theory
2013/1/30

Izumi, Keisuke
National Taiwan U, Cosmology
2012/12/2-12/5

Jacobson, Teodore
U Maryland, Gravity
2013/2/16-2/24

Jaffe, David
BNL, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Jafferis, Daniel
Harvard U, String Theory
2012/10/21-10/24

Jamieson, Blair
U Winnipeg, High Energy Physics
2013/1/14-1/15

Jarvis, Tyler
Brigham Young U, Mathematics
2012/6/26-6/29

Jeong, Donghui
Johns Hopkins U, Cosmology
2012/6/28-6/30

Joo, Changwoo
Seoul National U, High Energy Physics
2012/7/2-7/19, 2013/1/7-1/31

Joo, Kyung Kwang
Chonnam National U, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Jung, Chang Kee
SUNY, Stony Brook, High Energy Physics
2012/4/19-5/12, 5/27-6/16, 7/1-7/27, 8/19-8/24, 9/23-9/29, 2013/1/14-1/15

Kah, Dongha
Kyungpook National U, High Energy Physics
2012/6/28-7/13, 2013/1/8-1/25

Kahn, Steven
Stanford U/SLAC, Cosmology
2012/7/23-7/25

Kameda, Jun
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Kametani, Isao
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23

Kanda, Nobuyuki
Osaka City U, Astroparticle Physics
2012/8/21-8/23

Kang, KukHyun
Kyungpook National U, High Energy Physics
2012/6/28-7/20, 2013/1/8-1/25

Kapranov, Mikhail
Yale U, Mathematics
2012/8/13-8/25, 2013/1/12-1/19

Kapustin, Anton
Caltech, Particle Theory
2012/9/30-10/12

Kashino, Daichi
Nagoya U, Astronomy
2012/8/27-8/31, 2013/2/25-3/1

Kato, Eriko
Tohoku U, High Energy Physics
2012/6/11-6/16, 10/16-10/17

Kato, Mariko
Keio U, Astrophysics
2012/10/29

Katori, Teppei
MIT, Neutrino Physics
2013/2/4-2/7

Katzarkov, Ludmil
U Vienna, Mathematics
2012/11/11-11/16

Kawabata, Koji
Hiroshima U, Astronomy
2012/11/20-11/21

Kawahigashi, Yasuyuki
U Tokyo, Math Sci, Mathematics
2013/3/6-3/7

Kawai, Katsuhiko
Hamamatsu Photonics, Neutrino Physics
2012/8/21-8/23

Kawai, Yoshihiko
Hamamatsu Photonics, High Energy Physics
2013/1/14-1/15

Kawano, Isao
JAXA, Astronomy
2012/8/24

Kawasaki, Morimichi
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Kayo, Issha
Toho U, Astrophysics
2012/10/5, 10/23, 11/7, 12/4, 2013/3/25-3/28

Kearns, Edward
Boston U, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/18

Keenan, Ryan
ASIAA, Astronomy
2013/3/24-3/28

Khabibullin, Marat
INR RAS, High Energy Physics
2013/1/14-1/15

Kim, Jae Yool
Chonnam National U, High Energy Physics
2013/1/14-1/15

Kim, Soo-Bong
Seoul National U, High Energy Physics
2013/1/14-1/15

Kimura, Yusuke
Kyoto U, Particle Theory
2012/7/3-7/6, 7/24-7/27, 12/25-12/28, 2013/1/9

King, Stephen
U Southanpton, Particle Theory
2012/10/28-11/2

Kishimoto, Tadafumi
Osaka U, High Energy Physics
2012/8/21-8/23

Kishimoto, Yasuhiro
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23

Kleban, Matthew
New York U, Cosmology
2012/12/11-12/18

Knapp, Johanna
U Vienna, String Theory
2012/11/11-11/18

Kobayashi, Chiaki
U Hertfordshire, Astronomy
2012/11/16-11/18, 12/20-2013/1/20, 2/26-3/3, 3/30-4/14

Kobayashi, Takashi
KEK, High Energy Physics
2012/8/21-8/23

Kobayashi, Takeshi
CITA, Cosmology
2012/12/10-12/18

Kodali, Kameswara
Tata Inst, High Energy Physics
2012/6/2-7/14, 2013/3/4-3/23

Kohda, Masaya
National Taiwan U, Particle Theory
2012/11/21-11/28

Koike, Takayuki
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Kojima, Sadayoshi
Tokyo Tech, Mathematics
2012/7/24

Komarov, Stanislav
NPCMAPRO, Mathematics
2012/11/5-11/30

Komatsu, Eiichiro
U Texas, Cosmology
2012/6/1-7/31

Konaka, Akira
TRIUMF, Neutrino Physics
2012/8/21-8/23

Koseki, Tadashi
KEK, High Energy Physics
2012/8/21-8/23

Koshio, Yusuke
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Kromer, Markus
MPI for Astrophysics, Astrophysics
2012/10/20-11/3

Kropp, William
UC Irvine, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Kudenko, Yury
Russian Academy of Science, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Kulkarni, Shrinivas
Caltech, Astronomy
2012/10/8

Kuroyanagi, Sachiko
U Tokyo, RESCEU, Cosmology
2012/5/15

Kusenko, Alexander
UCLA, Particle Theory
2012/10/12-12/13

Kutter, Thomas
Louisiana State U, High Energy Physics
2012/8/21-8/23

Kuze, Masahiro
Tokyo Tech, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Kuznetsov, Alexander
Steklov Math Inst, Mathematics
2012/11/11-11/17

Kwan, Juliana
Argonne National Laboratory, Astrophysics
2013/3/7-3/8

Kyushima, Hiroyuki
Hamamatsu Photonics, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Labarga, Luis
UAM, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Lake, Matthew
U Tokyo, RESCEU, Cosmology
2012/10/29

Lang, Rafael
Purdue U, Astroparticle Physics
2013/3/8-3/9

Le Fevre, Olivier
LAM, Astronomy
2012/8/12-8/16

Le Mignant, David
LAM, Astronomy
2012/8/12-8/17, 2013/3/25-3/28

Lee, Hwayoung
KIAS, Mathematics
2012/12/6-12/13

Lee, Jae Hyouk
Ewha Woman's U, Mathematics
2012/6/24-6/28, 12/6-12/10

Lee, Sangwook
Seoul National U, Mathematics
2012/6/24-6/30

Lehner, Matthew
Academia Sinica, Cosmology
2012/5/7 -5/13

Li, Jun
Stanford U, Mathematics
2012/6/24-6/27

Li, Si
Northwestern U, Mathematics
2012/6/23-6/30
Boston U, Mathematics
2012/12/15-12/23

Li, Wei
MPI for Gravitational Physics, Golm, String Theory
2013/1/15-1/21

Lian, Bong
Brandeis U, Mathematics
2012/6/8

Liberati, Stefano
SISSA, Gravity
2013/2/17-2/23

Liew, Seng Pei
U Tokyo, Particle Theory
2013/1/22-1/25

Lim, In Taek
Chonnam National U, High Energy Physics
2013/1/14-1/15

Lin, Jing-Hua (Ching-Hua)
ASIAA, Astronomy
2013/3/24-3/27

Lin, Yen-Ting
ASIAA, Astrophysics
2012/12/3-12/7, 2013/3/24-3/27

Ling, Hung-Hsu
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2012/1/28-4/25, 5/14-6/30, 7/5-7/27, 8/10-8/11, 8/12-8/18, 8/19-10/27, 11/19-2013/1/21

Ling, Jiajie
BNL, Neutrino Physics
8/21-8/23

Liu, Jia
Columbia U, High Energy Physics
2013/1/14-1/15

Liu, Jianglai
Shanghai Jiao Tong U, Neutrino Physics
2012/8/21-8/23

Liu, Xiaowei
KIAA, Peking U, Astronomy
2012/5/8-5/11

Loomis, Craig
Princeton U, Cosmology
2012/7/22-8/1

Lorscheid, Oliver
IMPA, Mathematics
2012/11/3-11/11

Lundgren, Britt
U Wisconsin, Madison, Astronomy
2012/10/21-11/1

Lupton, Robert
Princeton U, Astronomy
2012/7/22-8/1, 2013/2/17-2/23, 3/24-3/29

Ma, Ernest
UC Riverside, Particle Theory
2012/4/2-4/29

Madec, Fabrice
LAM, Astronomy
2012/8/11-8/17, 2013/3/25-3/29

Mahn, Kendall
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2013/1/14-1/15, 1/27-1/31

Manecki, Szymon
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2012/8/21-8/23, 2013/1/14-1/15

Manolache, Cristina
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2013/1/23

Marc, Jaquet
LAM, Astronomy
2012/8/11-8/17

Marengo, Massimo
Iowa State U, Astrophysics
2012/5/28

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Virginia Tech, High Energy Physics
2013/1/14-1/15

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U Hawaii, Neutrino Physics
2012/8/21-8/23

Marti Magro, Lluis
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2012/8/21-8/23, 2013/1/14-1/15

Masaki, Shogo
Nagoya U, Cosmology
2012/6/20-6/22, 2013/2/19-2/22, 3/5-3/8

Matsubara, Takahiko
Nagoya U, KMI, Cosmology
2013/1/21-1/22

Matsuda, Yuichi
NAOJ, Chile, Astronomy
2013/3/25-3/28

Matsumura, Tomotake
KEK, Cosmology
2012/4/19, 8/24

Matsuno, Shige
U Hawaii, High Energy Physics
2013/1/14-1/15

Matsuoka, Kenta
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2012/5/24-5/31

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2012/8/21-8/23, 2013/1/14-1/15

Mayekar, Sukant Narendra
Tata Inst, High Energy Physics
2013/3/3-3/23

McAllister, Liam
Cornell U, String Theory
2012/10/9-10/11

McCauley, Neil
U Liverpool, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

McFarland, Kevin
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2012/8/21-8/23, 2013/1/14-1/15

Melia, Tom
U Oxford, Particle Theory
2012/8/10-10/10

Mellier, Yannick
IAP, Astrophysics
2012/5/27-6/7

Ménard, Brice
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2012/7/30-8/25, 2013/3/19-3/30

Mendes De Oliveira, Claudia Lucia
U Sao Paulo, Astronomy
2013/3/24-3/29

Meyer, Rene
U Crete, String Theory
2012/4/7-4/11

Meyers, Joel
CITA, Cosmology
2012/11/26-11/30

Mibe, Tsutomu
KEK, High Energy Physics
2012/10/15, 2013/3/19

Mihalcea, Leonardo
Virginia Tech, Mathematics
2012/7/30-8/1

Miller, Lance
U Oxford, Cosmology
2013/2/2-2/9

Minakata, Hisakazu
Tokyo Metropolitan U, Neutrino Physics
2012/8/21-8/23, 10/3

Minamino, Akihiro
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2012/8/21-8/23, 2013/1/14-1/15

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2012/8/21-8/23, 2013/1/14-1/15

Mitsuda, Kazuhisa
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2012/4/1-8/31, 12/27-12/28, 2013/3/21-3/28,

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2012/10/22

Mohanty, Gagan
Tata Inst, High Energy Physics
2013/3/18-3/19

Molinaro, Emiliano
CFTP, Particle Theory
2012/5/25-6/3

Morales, John Alexander Cruz
Tokyo Metropolitan U, Mathematics
2012/4/19-4/26, 6/25-6/29

Mori, Toshinori
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2012/8/21-8/23

Morishita, Takahiro
Tohoku U, Astronomy
2013/3/24-3/28

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2012/8/21-8/23, 2013/1/14-1/15

Morokuma, Tomoki
U Tokyo, IoA, Astronomy
2012/12/12-12/14

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2012/7/19-7/25

Morrison, Scott
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2013/3/3-3/9

Mould, Jeremy
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Moustakas, Leonidas
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2013/3/24-3/29

Mulase, Motohico
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2012/10/26-11/11

Mullaney, James
Durham U, Astronomy
2013/3/6

Murata, Jiro
Rikkyo U, Particle Theory
2013/2/6

Murayama, Satoshi
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2012/4/27, 5/16, 5/30, 6/11, 6/25, 8/8, 10/22

Murray, Graham
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2013/3/23-3/27

Nagai, Minoru
U Tokyo, High Energy Physics
2012/6/27

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Nagao, Kentaro
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2012/4/16

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2012/12/10

Nakajima, Reiko
AIFA, U Bonn, Astrophysics
2012/12/18, 2013/1/7-1/11

Nakamura, Katsuro
Kyoto U, High Energy Physics
2013/3/28

Nakamura, Koji
U Tokyo, ICEPP, High Energy Physics
2012/7/13

Nakamura, Yusuke
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Nakasato, Naohito
U Aizu, Astronomy
2012/10/25-10/26, 2013/1/25, 3/19

Nakaya, Tsuyoshi
Kyoto U, High Energy Physics
2013/1/14-1/15

Nakayama, Kazunori
U Tokyo, Cosmology
2012/4/18

Nakayama, Shoei
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Nakayama, Yu
Caltech, String Theory
2012/12/19-2013/1/10

Namba, Ryo
U Minnesota, Particle Theory
2012/9/5-9/7

Narikawa, Tatsuya
U Tokyo, RESCEU, Cosmology
2012/10/12, 10/26, 11/6, 12/7

Natsume, Kouta
Yokohama National U, Astrophysics
2012/4/27, 5/16, 5/30, 6/11, 6/25, 8/8, 10/22, 11/12

Negishi, Kentaro
Tohoku U, High Energy Physics
2012/6/3-6/10, 6/25-6/28, 7/2-7/18

Neubert, Sebastian
Technical U Munich, Nuclear Physics
2012/5/13-5/15

Niino, Yu
NAOJ, Astrophysics
2013/3/25-3/26

Nishimura, Yasuhiro
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Noda, Atsushi
JAXA, Astronomy
2012/8/24

Noll, Alexander
U Vienna, Mathematics
2012/11/11-11/17

Nomura, Ryosuke
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Oesch, Pascal
UC Santa Cruz, Astronomy
2013/1/31-2/5

Ogawa, Noriaki
KIAS, Particle Theory
2012/12/27-12/28

Ohashi, Ryosuke
Kyoto U, Mathematics
2013/1/11-1/12, 2/8-2/10, 2/15-2/16, 2/22-2/24, 3/1-3/3, 3/8-3/10, 3/14-3/16, 3/22-3/23

Ohmura, Takayuki
Hamamatsu Photonics, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Ohta, Hiroshi
Nagoya U, Mathematics
2012/6/25-6/29

Okabe, Nobuhiro
Academia Sinica, Astronomy
2012/6/4

Okada, Shigeru
Shimizu Corp
2012/8/21-8/23

Okada, Yasuhiro
KEK, Particle Theory
2012/8/21-8/23

Okajima, Satoru
U Tokyo, Mathematics
2013/1/22-1/25

Okajima, Yuji
Tokyo Tech, High Energy Physics
2013/1/14-1/15

Okamoto, Sakurako
KIAA, Peking U, Astronomy
2013/3/24-3/29

Okamura, Sadanori
U Tokyo, Astronomy
2012/7/24

Okuhara, Saki
Tokyo Metropolitan U, Mathematics
2012/6/25-6/29

Okumura, Kimihiro
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Okumura, Teppei
Ewha Woman's U, Cosmology
2013/1/28-1/31

Okuno, Tetsuo
Shimizu Corp
2012/8/21-8/23

Okura, Yuki
NAOJ, Astronomy
2012/6/4

Olinto, Angela
U Chicago, Astrophysics
2012/5/9-5/10

Olive, Keith
U Minnesota, Cosmology
2013/1/20-1/26

Ono, Kaoru
Kyoto U, Mathematics
2012/6/25-6/29

Onuki, Yoshiyuki
U Tokyo, ICEPP, High Energy Physics
2012/6/3-6/8, 6/11-6/19, 6/25-6/27, 10/15-10/17, 12/4-12/5, 12/17-12/19, 2013/2/18-2/19, 2/26-2/27, 3/11-3/14, 3/18-3/19, 3/25-3/27

Ookouchi, Yutaka
Kyoto U, String Theory
2012/4/25-4/28, 5/17-5/19

Orita, Ryuma
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Orlando, Domenico
CERN, String Theory
2012/4/9-5/14, 11/22-12/15

Otofuji, Takashi
Nihon U, Mathematics
2012/6/25-6/29

Ott, Christian
Caltech, Astrophysics
2012/6/9-6/13

Ouchi, Masami
U Tokyo, ICRR, Astronomy
2012/8/12-8/17

Overzier, Roderik
U Texas, Astrophysics
2012/6/25-6/29
Observatorio Nacional Rio de Janeiro Brasil, Astrophysics
2013/3/24-3/29

Padilla, Antonio
U Nottingham, Cosmology
2012/11/18-11/23

Pakmor, Ruediger
Heidelberg Inst for Theoretical Studies, Astrophysics
2012/10/20-11/3

Pandit, Pranav
U Vienna, Mathematics
2012/11/11-11/18

Panotopoulos, Grigoris
OIST, Cosmology
2012/9/18-9/21, 11/16-12/12

Pantev, Tony
U Pennsylvania, Mathematics
2012/11/11-11/17

Park , Jinhyung
KAIST, Mathematics
2013/1/11-1/14

Park, Chan Youn
Caltech, String Theory
2012/11/4-11/7

Pascal, Sandrine
LAM, Astronomy
2013/3/25-3/28

Pattarakijwanich, Petchara
Princeton U, Astronomy
2013/3/24-3/28

Paz, Gil
Wayne State U, Particle Theory
2013/3/10-3/11

Peccei, Roberto
UCLA, Particle Theory
2012/7/22-7/25

Peloso, Marco
U Minnesota, Particle Theory
2012/7/7-7/14

Pereira Dominici Tania
LNA, Astronomy
2013/3/23-3/31

Petcov, Serguey
SISSA, Particle Theory
2012/4/24-6/2, 11/2-11/24, 2013/2/26-3/8, 3/19-4/21

Pignata, Giuliano
U Andrés Bello, Astronomy
2012/12/8-12/21

Pillepich, Annalisa
UC Santa Cruz, Astronomy
2013/1/31-2/4

Pinner, David
UC Berkeley, Particle Theory
2012/7/29-8/19

Pospelov, Maxim
U Victoria, Cosmology
2013/2/17-2/23

Poutissou, Jean-Michel
TRIUMF, High Energy Physics
2013/1/14-1/15

Price, Paul
Princeton U, Astrophysics
2012/7/18-7/28, 2013/2/16-3/2

Pritchard, Jonathan
Imperial Coll. London, Astrophysics
2012/11/5

Prudenziati, Andrea
Kyoto U, String Theory
2012/5/14-5/17

Przhiyalkovskiy (Przyjalkowski), Victor
Steklov Math Inst, Mathematics
2012/11/11-11/18

Pujolas, Oriol
U Autonoma Barcelona, Cosmology
2013/2/18-2/22

Raaf, Jennifer
Fermilab, High Energy Physics
2013/1/14-1/15

Raccanelli, Alvise
NASA JPL/Caltech, Astronomy
2013/3/23-3/30

Redi, Michel
INFN, Particle Theory
2013/3/11-3/14

Reffert, Susanne
CERN, String Theory
2012/4/9-5/14, 11/22-12/15

Reid, Beth
LBL, Berkeley, Cosmology
2013/1/21-1/25

Reiley, Daniel J. (Dan)
Caltech, Astronomy
2013/3/24-3/27

Retiere, Fabrice
TRIUMF, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Richard, Euan
U Tokyo, ICRR, High Energy Physics
2013/1/14-1/15

Rizzardo, Alice
SISSA, Mathematics
2012/11/11-11/17

Rott, Carsten
Ohio State U, Astrophysics
2012/8/21-8/23, 2013/1/14-1/15

Ruan, Yongbin
U Michigan, Mathematics
2012/6/10-7/8

Rubbia, Andre
ETH Zurich, Neutrino Physics
2012/8/21-8/23

Ruiz, Richard
U Pittsburgh, Particle Theory
2012/6/19-8/21

Ruiz, Sergio
CFTP, Astroparticle Physics
2012/5/25-6/3

Rujopakarn, Wiphu
U Arizona, Astronomy
2013/3/18-3/19

Rusu, Cristian
NAOJ, Cosmology
2013/3/4, 3/25-3/26

Rychkov, Vyacheslav
Pierre and Marie Curie U, High Energy Physics
2013/1/7-1/11

Sahu, Devendra Kumar
IIAP, Astronomy
2012/11/18-12/19

Saito, Naohito
KEK, High Energy Physics
2012/8/21-8/23

Saito, Shun
UC Berkeley, Cosmology
2013/3/11-3/17

Saito, Takeshi
U Tokyo Math Sci, Mathematics
2013/2/20

Sakuda, Makoto
Okayama U, Neutrino Physics
2012/8/21-8/23

Sakurai, Kazuki
DESY, Particle Theory
2012/8/28-8/31

Sami, Mohammad
Jamia Millia Islamia, Cosmology
2013/3/1-3/22

Samsing, Johan
LBL, Berkeley, Cosmology
2012/10/23-10/24

Sato, Yushi
U Tokyo, Astronomy
2012/10/25-10/26, 2013/1/25, 2/8, 3/19

Satoh, Yuji
U Tsukuba , Particle Theory
2012/7/31

Sawicki, Marcin
Saint Mary's U, Cosmology
2013/3/6-3/8

Schapira, Pierre
Pierre and Marie Curie U, Mathematics
2012/10/2-10/5

Scheidegger, Emanuel
U Freiburg, Mathematical Physics
2012/5/18-6/3, 11/11-11/18

Schmidt, Brian
Australian National U, Astronomy
2012/11/19-11/21

Schmidt, Fabian
Caltech, Cosmology
2012/4/10-4/20

Schnabl, Martin
Inst Phys AS CR, String Theory
2012/11/26-11/28

Schnetler, Hermine
UK ATC, Astronomy
2013/2/22-3/1

Scholberg, Kate
Duke U, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Schroers, Bernd
Heriot-Watt U, Mathematical Physics
2012/10/20-11/5

Schuller, Frederic
MPI for Gravitational Physics, Hannover, Mathematical Physics
2012/4/8-4/15

Schwetz-Mangold, Thomas
MPI for Nuclear Physics Heidelberg, Particle Theory
2012/5/29-6/2

Schwochert, Mark
NASA JPL/Caltech, Astronomy
2013/3/24-3/29

Scott, Douglas
U British Columbia, Cosmology
2013/2/18

Scudder, Jillian
U Victoria, Astronomy
2012/10/2-10/3

Sekiya, Hiroyuki
U Tokyo, ICRR, Astroparticle Physics
2012/8/21-8/23, 2013/1/14-1/15

Seljak, Uros
UC Berkeley, Astrophysics
2012/6/8

Seong, Rak-Kyeong
Imperial Coll. London, String Theory
2012/9/2-9/6

Seto, Osamu
Hokkai-Gakuen U, Particle Theory
2013/1/23-1/26

Shadrin, Sergey
U Amsterdam, Mathematics
2012/6/25-6/30

Sharankova, Ralitsa
Tokyo Tech, High Energy Physics
2013/1/14-1/15

Sharpe, Eric
Virginia Tech, String Theory
2012/11/11-11/17

Sharples, Ray Martin
Durham U, Astronomy
2013/2/23-2/27

Shen, Yefeng
U Michigan, Mathematics
2013/2/3-8/31

Sheridan, Nicholas
MIT, Mathematics
2012/6/23-6/30

Sheshmani, Artan
MPI for Mathematics, Mathematics
2013/2/3-2/11

Shifman, Mikhail
FTPI, High Energy Physics
2012/12/1-12/3

Shimizu, Akie
KEK, High Energy Physics
2012/4/5-7/31

Shimizu, Itaru
Tohoku U, High Energy Physics
2013/1/14-1/15

Shimizu, Yuji
ICU, Mathematics
2012/6/25-6/29

Shiozawa, Masato
U Tokyo, ICRR, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Shirai, Satoshi
UC Berkeley, Particle Theory
2012/12/20-12/26, 2013/1/7-1/14

Shiromizu, Tetsuya
Kyoto U, String Theory
2012/6/20-6/21

Shu, Jing
Chinese Academy of Sciences, Particle Theory
2013/1/8-1/10

Sibiryakov, Sergey
Russian Academy of Science, Field Theory
2013/2/18-2/24

Sinnis, Gus
Los Alamos National Lab, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Skinner, David
Perimeter Inst, String Theory
2012/5/20-5/24

Smirnov, Fedor
LPTHE, Mathematics
2012/11/25-12/1

Smith, Kendrick
Princeton U, Cosmology
2013/2/19-3/2

Smith, Nigel
SNO, High Energy Physics
2012/7/23-7/26

Smoot, George
LBL, Berkeley, Astrophysics
2013/3/24-3/25

Smy, Michael
UC Irvine, Neutrino Physics
2012/5/14-5/21, 8/21-8/23, 2013/1/14-1/15

Snyder, Noah
Indiana U. Bloomington, Mathematics
2013/3/2-3/9

Sobel, Henry
UC Irvine, Astroparticle Physics
2012/4/16-4/20, 8/21-8/25, 2013/1/14-1/15

Soda, Jiro
Kyoto U, Cosmology
2013/2/17-2/22

Sodre, Laerte
U Sao Paulo, Astronomy
2013/3/24-3/29

Song, Jaewon
UC San Diego, String Theory
2012/12/4-12/13

Song, Ruifang
U Wisconsin, Madison, Mathematics
2012/6/22-6/30

Sorokina, Elena
Sternberg Astro Inst, Astrophysics
2013/2/2-3/1

Sosna, Pawel
U Hamburg, Mathematics
2012/11/5-11/16

Sotiriou, Thomas
SISSA, Cosmology
2013/2/16-2/23

Souza De Oliveira, Ligia
LNA, Astronomy
2013/1/20-1/25, 3/23-3/31

Spolyar, Douglas
Fermilab, Astroparticle Physics
2012/5/12-5/18

Sreekantan, Ramesh Badanval
Indian Statistical Inst, Mathematics
2012/11/9-11/23

Starobinsky, Alexei
Russian Academy of Sciences, Cosmology
2013/1/23

Steinhardt, Paul
Princeton U, Cosmology
2012/8/10-8/18

Stewart, James
BNL, Neutrino Physics
2012/8/21-8/23

Stoll, Martin
U Tokyo, Particle Theory
2013/1/22-1/25

Stone, James
Boston U, High Energy Physics
2012/5/15-5/24, 8/21-8/23, 2013/1/14-1/15

Strauss, Michael
Princeton U, Astronomy
2013/3/23-3/27

Stritzinger, Maximilian
Aarhus U, Astronomy
2012/6/21-7/4

Su, Shufang
U Arizona, Particle Theory
2013/3/8

Suda, Yusuke
U Tokyo, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Sudo, Kae
Konan U, Astronomy
2013/3/24-3/28

Sugiyama, Naonori
Tohoku U, Cosmology
2012/7/25-7/31

Sugiyama, Satoshi
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Sumi, Takahiro
Osaka U, Astroparticle Physics
2012/6/1

Sundaram, S.K.
Alfred U, Condensed matter Physics
2012/8/21-8/23

Suyu, Sherry
ASIAA, Astronomy
2013/3/24-4/3

Suzuki, Aritoki
UC Berkeley, Astrophysics
2012/4/10

Suzuki, Atsumu
Kobe U, High Energy Physics
2013/1/14-1/15

Suzuki, Nao
LBL, Berkeley, Astrophysics
2012/3/2-5/31, 7/2-7/4

Svoboda, Robert
UC Davis, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Tachibana, Motoi
Saga U, Nuclear Physics
2012/9/26

Takahashi, Atsushi
Osaka U, Mathematical Physics
2012/4/4-4/5, 6/26-6/28

Takahashi, Ryuichi
Hirosaki U, Astronomy
2013/3/25-3/26

Takaki, Katsutoshi
Hiroshima U, Astronomy
2012/12/12-12/14

Takato, Naruhisa
NAOJ, Hawaii, Astronomy
2013/3/27-3/28

Takeda, Atsushi
U Tokyo, ICRR, Astroparticle Physics
2013/1/14-1/15

Taketa, Akimichi
ERI, U Tokyo, High Energy Physics
2013/1/14-1/15

Takeuchi, Michihisa
King's Coll. London, Particle Theory
2013/3/8-3/18

Takeuchi, Tatsu
Virginia Tech, Particle Theory
2012/9/1-2013/8/15

Takeuchi, Yasuo
Kobe U, Astroparticle Physics
2013/1/14-1/15

Takhistov, Volodymyr
UC Irvine, High Energy Physics
2012/8/21-8/24

Tanaka, Hide-Kazu
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Tanaka, Hirohisa
U British Columbia, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Tanaka, Hiroyuki
U Tokyo, ERI, High Energy Physics
2013/1/14-1/15

Tanaka, Masaomi
NAOJ, Astronomy
2012/10/24, 11/1, 12/13-12/21

Tanaka, Mikito
Tohoku U, Astronomy
2013/3/25-3/28

Tanaka, Yasuo
MPI for Extraterrestrial Physics, Astrophysics
2012/10/15-10/17, 12/10-12/11

Tanaka, Yuichiro
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Tanikawa, Ataru
U Aizu, Astrophysics
2012/10/25-10/26, 2013/1/25, 2/8, 3/19

Tanizaki, Yuya
U Tokyo, Particle Theory
2013/1/22-1/25

Taruya, Atsushi
U Tokyo, Astrophysics
2012/5/16

Tasker, Elizabeth
Hokkaido U, Astrophysics
2012/7/11-7/16

Tateishi, Keiji
Kyoto U, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Tattersall, Jamie
U Bonn, Particle Theory
2013/2/24-3/3

Tobayama, Shimpei
U British Columbia, High Energy Physics
2013/1/14-1/15

Tojo, Koichi
U Tokyo, Mathematics
2013/1/22-1/25

Toma, Kenji
Osaka U, Astroparticle Physics
2013/2/18-2/22

Tominaga, Nozomu
Konan U, Astrophysics
2012/4/16-4/17, 10/30, 11/16-11/17, 12/12/16, 12/27, 2013/2/7, 3/25 -3/28

Tonegawa, Motonari
Kyoto U, Astronomy
2013/2/5-2/7

Toyouchi, Daisuke
Tohoku U, Astronomy
2013/3/25-3/28

Trenti, Michele
U Cambridge, Astronomy
2012/6/1

Tresse, Laurence
LAM, Astronomy
2012/8/11-8/18, 2013/3/25-3/29

Treu, Tommaso
UC Santa Barbara, Astrophysics
2012/9/21

Trodden, Mark
U Pennsylvania, Cosmology
2012/10/11-10/18

Tseng, Hsian-Hua
Ohio State U, Mathematics
2012/6/25-6/29

Tsuboyama, Toru
KEK, High Energy Physics
2012/7/10, 8/7, 10/9, 10/16-10/17, 10/23, 11/1-11/2, 11/18, 11/20, 12/4, 12/7, 12/11, 12/17, 12/25, 12/28, 2013/1/8, 1/10, 1/17, 1/22, 1/24, 1/29, 1/31, 2/12, 2/14-2/15, 2/19, 2/26, 3/12-3/13, 3/21-3/22, 3/26, 3/28

Tsujikawa, Shinji
Tokyo U of Science, Cosmology
2013/2/18-2/22

Tsukamoto, Toshifumi
KEK, High Energy Physics
2013/1/14-1/15

Tsunoda, Kenkichi
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Tsuruta, Sachiko
Montana State U, Astrophysics
2012/12/14-12/21, 12/25-12/28

Turner, Edwin
Princeton U, Astrophysics
2012/5/30-6/16, 9/1-9/7, 10/17-11/3

Tye, Henry
Cornell U, Particle Theory
2012/10/2-10/4

Ubaldi, Lorenzo
U Bonn, Particle Theory
2012/8/8-8/13

Ueda, Akitoshi
NAOJ, Astronomy
2013/3/24-3/28

Uehara, Hokuto
Tokyo Metropolitan U, Mathematics
2012/6/25-6/29

Ueno, Kazuki
KEK, High Energy Physics
2012/10/15

Uozumi, Satoru
Kyungpook National U, High Energy Physics
2013/3/12

Usuda, Tomonori
NAOJ, Hawaii, Astronomy
2013/2/25-2/27

Uzan, Jean-Philippe
IAP, Cosmology
2012/12/15-12/20

Valdes, Marcos
Scuola Normale Superiore di Pisa, Astrophysics
2012/5/29-6/11

Van der Geer, Gerard
U Amsterdam, Mathematics
2013/1/24

Van Straten, Duco
U Mainz, Mathematics
2012/4/4-4/7

Verbitsky, Misha
HSE, National Research U, Mathematics
2012/12/16-2013/1/15

Vieira, Pedro
Perimeter Inst, String Theory
2012/10/6-10/11

Visser, Matt
Victoria U Wellington, Cosmology
2013/2/16-2/23

Vives, Sebastien
LAM, Astronomy
2012/8/11-8/18, 2013/3/24-3/28

Volonteri, Marta
IAP, Astronomy
2012/5/16-5/18

Wakabayashi, Naruki
Shimizu Corp
2012/8/21-8/23

Wake, David
U Wisconsin, Madison, Astronomy
2012/10/21-11/1, 2013/3/23-3/28

Walter, Christopher
Duke U, Neutrino Physics
2012/5/14-5/23, 8/8-8/24, 2013/1/14-1/15

Wandel, Malte
U Hannover, Mathematics
2012/10/1-12/16

Wang, Anzhong
Baylor U, Cosmology
2013/2/18-2/22

Wang, Liucheng
Zhejiang U, High Energy Physics
2013/3/10-3/15

Wark, David
Rutherford Appleton Laboratory, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Webber, Alfons
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2012/8/21-8/23

Weiland, Cedric
U Paris-Sud 11, Particle Theory
2012/6/19-8/21

Wendell, Roger Alexandre
U Tokyo, ICRR, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Wetzel, Andrew
Yale U, Cosmology
2013/2/4-2/8

Wilking, Michael
TRIUMF, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Williams, Rik
Carnegie Obs, Astronomy
2013/1/21-1/25

Wilson, John
U Virginia, Astronomy
2013/2/23-2/27

Witkowski, Lukas
U Oxford, Particle Theory
2012/11/5-11/9

Wolk, Melody
IAP, Cosmology
2012/11/5-11/10

Wongjirad, Taritree
Duke U, High Energy Physics
2013/1/14-1/15

Wright, Edward
UCLA, Astronomy
2012/11/9-11/27

Wu, Jackson
NCTS, String Theory
2013/3/14

Wu, Yue-Liang
KITPC, Astrophysics
2012/5/8-5/11

Wyse, Rosemary
Johns Hopkins U, Astronomy
2013/3/24-3/29

Xie, Dan
IAS, Particle Theory
2012/5/7-5/13

Yabe, Suguru
U Tokyo, Mathematics
2013/1/22-1/25

Yahiro, Kohei
U Tokyo, Math Sci, Mathematics
2012/6/25-6/29

Yamada, Toru
Tohoku U, Astronomy
2012/6/1, 8/13-8/18

Yamaguchi, Hiroya
Harvard U, Astronomy
2012/10/14-10/20, 2013/2/26

Yamamoto, Kazuhiro
Osaka City U, High Energy Physics
2012/8/21-8/23

Yamanaka, Masayuki
Kyoto U, Astronomy
2012/12/10-12/14

Yamauchi, Hiroshi
Tokyo Woman's Christian U, Mathematics
2013/3/7

Yamauchi, Koichi
Yokohama National U, Astrophysics
2012/10/22

Yamazaki, Masahito
Princeton U, String Theory
2012/10/9-10/11

Yanagida, Shintaro
Kyoto U, Mathematics
2012/5/7

Yano, Takatomi
Okayama U, Neutrino Physics
2012/8/21-8/23, 2013/1/14-1/15

Yasuda, Takehiko
Osaka U, Mathematics
2012/8/27-8/28

Yi, Piljin
KIAS, String Theory
2012/11/18-11/30

Yip, Ching-Wa
Johns Hopkins U, Astronomy
2013/3/24-3/29

Yokoyama, Masashi
U Tokyo, High Energy Physics
2012/8/21-8/23, 2013/1/14-1/15

Yonezawa, Yasuyoshi
Nagoya U, Mathematics
2012/9/10

Yoshida, Ken'chi
U Tokyo, Math Sci, Mathematics
2013/1/22-1/25

Yoshinaga, Masahiko
Kyoto U, Mathematics
2013/3/28-3/30

Yotsumoto, Kazuhiko
JAXA, Astronomy
2012/8/24

You, Tevong
Imperial Coll. London, Particle Theory
2012/8/21-8/24

Yu, Hoi-Lai
Academia Sinica, Cosmology
2012/11/28-11/29

Yui, Noriko
Queen's U, Mathematics
2012/6/17-6/29

Zhang, Ying-li
Kyoto U, Cosmology
2012/11/16-11/21

Zhdanovskiy, Ilya
MITP, Mathematics
2012/10/16-10/23

Zinn, Joel
Princeton U, Astronomy
2012/6/3-8/13

Zukowski, Claire
UC Berkeley, Cosmology
2012/10/5-10/19

12 Publications

JFY2012

1. DISCOVERY OF SMALL-SCALE SPIRAL STRUCTURES IN THE DISK OF SAO 206462 (HD 135344B): IMPLICATIONS FOR THE PHYSICAL STATE OF THE DISK FROM SPIRAL DENSITY WAVE THEORY
T. Muto, C. A. Grady, J. Hashimoto, M. Fukagawa, J. B. Hornbeck, M. Sitko, R. Russell, C. Werren, M. Cure, T. Currie, N. Ohashi, Y. Okamoto, M. Momose, M. Honda, S. Inutsuka, T. Takeuchi, R. Dong, L. Abe, W. Brandner, T. Brandt, J. Carson, S. Egner, M. Feldt, T. Fukue, M. Goto, O. Guyon, Y. Hayano, M. Hayashi, S. Hayashi, T. Henning, K. W. Hodapp, M. Ishii, M. Iye, M. Janson, R. Kandori, G. R. Knapp, T. Kudo, N. Kusakabe, M. Kuzuhara, T. Matsuo, S. Mayama, M. W. McElwain, S. Miyama, J-I Morino, A. Moro-Martin, T. Nishimura, T-S Pyo, E. Serabyn, H. Suto, R. Suzuki, M. Takami, N. Takato, H. Terada, C. Thalmann, D. Tomono, E. L. Turner, M. Watanabe, J. P. Wisniewski, T. Yamada, H. Takami, T. Usuda, M. Tamura
Astrophysical Journal Letters, **748**, L22, 2012

2. GENERALIZED MOONSHINE, II: BORCHERDS PRODUCTS
Scott Carnahan
Duke Mathematical Journal, **161**, 893, 2012

3. THE TAIWAN ECDFS NEAR-INFRARED SURVEY: VERY BRIGHT END OF THE LUMINOSITY FUNCTION AT z > 7
Bau-Ching Hsieh, Wei-Hao Wang, Haojing Yan, Lihwai Lin, Hiroshi Karoji, Jeremy Lim, Paul T. P. Ho, Chao-Wei Tsai
Astrophysical Journal, **749**, 88, 2012

4. Revisiting leptogenesis in a SUSY $SU(5) \times T'$ model of flavour
A. Meroni, E. Molinaro, S. T. Petcov
Physics Letters B, **710**, 435, 2012

5. Measurement of the $\beta\beta$ decay half-life of ^{136}Xe with the KamLAND-Zen experiment
A. Gando, Y. Gando, H. Hanakago, H. Ikeda, K. Inoue, R. Kato, M. Koga, S. Matsuda, T. Mitsui, T. Nakada, K. Nakamura, A. Obata, A. Oki, Y. Ono, I. Shimizu, J. Shirai, A. Suzuki, Y. Takemoto, K. Tamae, K. Ueshima, H. Watanabe, B. D. Xu, S. Yamada, H. Yoshida, A. Kozlov, S. Yoshida, T. I. Banks, J. A. Detwiler, S. J. Freedman, B. K. Fujikawa, K. Han, T. O'Donnell, B. E. Berger, Y. Efremenko, H. J. Karwowski, D. M. Markoff, W. Tornow, S. Enomoto, M. P. Decowski
Physical Review C, **85**, 45504, 2012

6. Instability in Magnetic Materials with a Dynamical Axion Field
Hirosi Ooguri, Masaki Oshikawa
Physical Review Letters, **108**, 161803, 2012

7. X-Ray Groups of Galaxies at 0.5 < z < 1 in zCOSMOS: Increased AGN Activities in High Redshift Groups
Masayuki Tanaka, Alexis Finoguenov, Simon J. Lilly, Micol Bolzonella, C. Marcella Carollo, Thierry Contini, Angela Iovino, Jean-Paul Kneib, Fabrice Lamareille, Olivier Le Fevre, Vincenzo Mainieri, Valentina Presotto, Alvio Renzini, Marco Scodeggio, John D. Silverman, Gianni Zamorani, Sandro Bardelli, Angela Bongiorno, Karina Caputi, Olga Cucciati, Sylvain de la Torre, Loic de Ravel, Paolo Franzetti, Bianca Garilli, Pawel Kampczyk, Christian Knobel, Katarina Kovac, Jean-Francois Le Borgne, Vincent Le Brun, Carlos Lopez-Sanjuan, Christian Maier, Marco Mignoli, Roser Pello, Yingjie Peng, Enrique Perez-Montero, Lidia Tasca, Laurence Tresse, Daniela Vergani, Elena Zucca, Luke Barnes, Rongmon Bordoloi, Alberto Cappi, Andrea Cimatti, Graziano Coppa, Anton M. Koekemoer, Henry J. McCracken, Michele Moresco, Preethi Nair, Pascal Oesch, Lucia Pozzetti, Niraj Welikala
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8. A Method of Identifying AGNs Based on Emission-Line Excess and the Nature of Low-Luminosity AGNs in the Sloan Digital Sky Survey. I. A New Method
Masayuki Tanaka
Publications of the Astronomical Society of Japan, **64**, 361, 2012

9. A Method of Identifying AGNs Based on Emission-Line Excess and the Nature of Low-Luminosity AGNs in the Sloan Digital Sky Survey. II. The Nature of Low-Luminosity AGNs
Masayuki Tanaka
Publications of the Astronomical Society of Japan, **64**, 371, 2012

10. Gravity dual for the Hofman-Strominger theorem
Yu Nakayama
Physical Review D, **85**, 85032, 2012

11. Exploring Three-Nucleon Forces in Lattice QCD
Takumi Doi, Sinya Aoki, Tetsuo Hatsuda, Yoichi Ikeda, Takashi Inoue, Noriyoshi Ishii, Keiko Murano, Hidekatsu Nemura, Kenji Sasaki
Progress of Theoretical Physics, **127**, 723, 2012

12. EVIDENCE FOR TYPE Ia SUPERNOVA DIVERSITY FROM ULTRAVIOLET OBSERVATIONS WITH THE HUBBLE SPACE TELESCOPE
Xiaofeng Wang, Lifan Wang, Alexei V. Filippenko, Eddie Baron, Markus Kromer, Dennis Jack, Tianmeng Zhang, Greg Aldering, Pierre Antilogus, W. David Arnett, Dietrich Baade, Brian J. Barris, Stefano Benetti, Patrice Bouchet, Adam S. Burrows, Ramon Canal, Enrico Cappellaro, Raymond G. Carlberg, Elisa di Carlo, Peter J. Challis, Arlin P. S. Crotts, John I. Danziger, Massimo Della Valle, Michael Fink, Ryan J. Foley, Claes Fransson, Avishay Gal-Yam, Peter M. Garnavich, Chris L. Gerardy, Gerson Goldhaber, Mario Hamuy, Wolfgang Hillebrandt, Peter Hoeflich, Stephen T. Holland, Daniel E. Holz, John P. Hughes, David J. Jeffery, Saurabh W. Jha, Dan Kasen, Alexei M. Khokhlov, Robert P. Kirshner, Robert A. Knop, Cecilia Kozma, Kevin Krisciunas, Brian C. Lee, Bruno Leibundgut, Eric J. Lentz, Douglas C. Leonard, Walter H. G. Lewin, Weidong Li, Mario Livio, Peter Lundqvist, Dan Maoz, Thomas Matheson, Paolo A. Mazzali, Peter Meikle, Gajus Miknaitis, Peter A. Milne, Stefan W. Mochnacki, Ken'ichi Nomoto, Peter E. Nugent, Elaine S. Oran, Nino Panagia, Saul Perlmutter, Mark M. Phillips, Philip Pinto, Dovi Poznanski, Christopher J. Pritchet, Martin Reinecke, Adam G. Riess, Pilar Ruiz-Lapuente, Richard A. Scalzo, Eric M. Schlegel, Brian P. Schmidt, James Siegrist, Alicia M. Soderberg, Jesper Sollerman, George Sonneborn, Anthony Spadafora, Jason Spyromilio, Richard A. Sramek, Sumner G. Starrfield, Louis G. Strolger, Nicholas B. Suntzeff, Rollin C. Thomas, John L. Tonry, Amedeo Tornambe, James W. Truran, Massimo Turatto, Michael Turner, Schuyler D. Van Dyk, Kurt W. Weiler, J. Craig Wheeler, Michael Wood-Vasey, Stanford E. Woosley, Hitoshi Yamaoka
Astrophysical Journal, **749**, 126, 2012

13. General Omega deformations from closed string backgrounds
Susanne Reffert
Journal of High Energy Physics, **4**, 59, 2012

14. PRESUPERNOVA EVOLUTION AND EXPLOSIVE NUCLEOSYNTHESIS OF ZERO METAL MASSIVE STARS
M. Limongi, A. Chieffi
Astrophysical Journal Supplement Series, **199**, 38, 2012

15. A SEARCH FOR INFRARED EMISSION FROM CORE-COLLAPSE SUPERNOVAE AT THE TRANSITIONAL PHASE
Masaomi Tanaka, Takaya Nozawa, Itsuki Sakon, Takashi Onaka, Ko Arimatsu, Ryo Ohsawa, Keiichi Maeda, Takehiko Wada, Hideo Matsuhara, Hidehiro Kaneda
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16. MEASURING THE GEOMETRY OF THE UNIVERSE FROM WEAK GRAVITATIONAL LENSING BEHIND GALAXY GROUPS IN THE HST COSMOS SURVEY
James E. Taylor, Richard J. Massey, Alexie Leauthaud, Matthew R. George, Jason Rhodes, Thomas D. Kitching, Peter Capak, Richard Ellis, Alexis Finoguenov, Olivier Ilbert, Eric Jullo, Jean-Paul Kneib, Anton M. Koekemoer, Nick Scoville, Masayuki Tanaka
Astrophysical Journal, **749**, 127, 2012

17. ELEMENTAL ABUNDANCES IN THE POSSIBLE TYPE Ia SUPERNOVA REMNANT G344.7-0.1
H. Yamaguchi, M. Tanaka, K. Maeda, P. O. Slane, A. Foster, R. K. Smith, S. Katsuda, R. Yoshii
Astrophysical Journal, **749**, 137, 2012

18. Mirror maps equal SYZ maps for toric Calabi-Yau surfaces
Siu-Cheong Lau, Naichung Conan Leung, Baosen Wu
Bulletin of the London Mathematical Society, **44**, 255, 2012

19. Detection Technique for Artificially Illuminated Objects in the Outer Solar System and Beyond
Abraham Loeb, Edwin L. Turner
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20. Higher genus BMN correlators: factorization and recursion relations
Min-xin Huang
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21. Hadron interactions from lattice QCD
T. Hatsuda
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22. Primordial seeds of supermassive black holes
Masahiro Kawasaki, Alexander Kusenko, Tsutomu T. Yanagida
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23. PROGENITORS OF RECOMBINING SUPERNOVA REMNANTS
Takashi J. Moriya
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24. Hubble induced mass in radiation-dominated universe
Masahiro Kawasaki, Tomohiro Takesako
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25. A 125 GeV Higgs boson and muon $g - 2$ in more generic gauge mediation
Jason L. Evans, Masahiro Ibe, Satoshi Shirai, Tsutomu T. Yanagida
Physical Review D, **85**, 95004, 2012

26. Higgs mass and muon anomalous magnetic moment in the U(1)- extended MSSM
Motoi Endo, Koichi Hamaguchi, Sho Iwamoto, Kazunori Nakayama, Norimi Yokozaki
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27. Randall-Sundrum graviton spin determination using azimuthal angular dependence
Hitoshi Murayama, Vikram Rentala
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28. THE MISSING CAVITIES IN THE SEEDS POLARIZED SCATTERED LIGHT IMAGES OF TRANSITIONAL PROTOPLANETARY DISKS: A GENERIC DISK MODEL
R. Dong, R. Rafikov, Z. Zhu, L. Hartmann, B. Whitney, T. Brandt, T. Muto, J. Hashimoto, C. Grady, K. Follette, M. Kuzuhara, R. Tanii, Y. Itoh, C. Thalmann, J. Wisniewski, S. Mayama, M. Janson, L. Abe, W. Brandner, J. Carson, S. Egner, M. Feldt, M. Goto, O. Guyon, Y. Hayano, M. Hayashi, S. Hayashi, T. Henning, K. W. Hodapp, M. Honda, S. Inutsuka, M. Ishii, M. Iye, R. Kandori, G. R. Knapp, T. Kudo, N. Kusakabe, T. Matsuo, M. W. McElwain, S. Miyama, J. -I. Morino, A. Moro-Martin, T. Nishimura, T. -S. Pyo, H. Suto, R. Suzuki, M. Takami, N. Takato, H. Terada, D. Tomono, E. L. Turner, M. Watanabe, T. Yamada, H. Takami, T. Usuda, M. Tamura
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Damien A. Easson, Paul H. Frampton, George F. Smoot
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Masahiro Ibe, Shigeki Matsumoto, Tsutomu T. Yanagida
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Motoi Endo, Koichi Hamaguchi, Sho Iwamoto, Norimi Yokozaki
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32. THE ATACAMA COSMOLOGY TELESCOPE: HIGH-RESOLUTION SUNYAEV-ZEL'DOVICH ARRAY OBSERVATIONS OF ACT SZE-SELECTED CLUSTERS FROM THE EQUATORIAL STRIP
Erik D. Reese, Tony Mroczkowski, Felipe Menanteau, Matt Hilton, Jonathan Sievers, Paula Aguirre, John William Appel, Andrew J. Baker, J. Richard Bond, Sudeep Das, Mark J. Devlin, Simon R. Dicker, Rolando Duenner, Thomas Essinger-Hileman, Joseph W. Fowler, Amir Hajian, Mark Halpern, Matthew Hasselfield, J. Colin Hill, Adam D. Hincks, Kevin M. Huffenberger, John P. Hughes, Kent D. Irwin, Jeff Klein, Arthur Kosowsky, Yen-Ting Lin, Tobias A. Marriage, Danica Marsden, Kavilan Moodley, Michael D. Niemack, Michael R. Nolta, Lyman A. Page, Lucas Parker, Bruce Partridge, Felipe Rojas, Neelima Sehgal, Cristobal Sifon, David N. Spergel, Suzanne T. Staggs, Daniel S. Swetz, Eric R. Switzer, Robert Thornton, Hy Trac, Edward J. Wollack
Astrophysical Journal, **751**, 12, 2012

33. ON WEAK REDSHIFT DEPENDENCE OF GAMMA-RAY SPECTRA OF DISTANT BLAZARS
Warren Essey, Alexander Kusenko
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34. Production of dark matter axions from collapse of string-wall systems
Takashi Hiramatsu, Masahiro Kawasaki, Ken'ichi Saikawa, Toyokazu Sekiguchi
Physical Review D, **85**, 105020, 2012

35. Equation of state in 2+1 flavor QCD with improved Wilson quarks by the fixed scale approach
T. Umeda, S. Aoki, S. Ejiri, T. Hatsuda, K. Kanaya, H. Ohno, Y. Maezawa
Physical Review D, **85**, 94508, 2012

36. Stochastic gravitational wave background originating from halo mergers
Takahiro Inagaki, Keitaro Takahashi, Naoshi Sugiyama
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37. Electroweak Beautygenesis: From $b \to s$ CP Violation to the Cosmic Baryon Asymmetry
Tao Liu, Michael J. Ramsey-Musolf, Jing Shu
Physical Review Letters, **108**, 221301, 2012

38. How much H and He is 'hidden' in SNe Ib/c? - I. Low-mass objects
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39. THE COSMIC NEAR INFRARED BACKGROUND. III. FLUCTUATIONS, REIONIZATION, AND THE EFFECTS OF MINIMUM MASS AND SELF-REGULATION
Elizabeth R. Fernandez, Ilian T. Iliev, Eiichiro Komatsu, Paul R. Shapiro
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40. THE SLOAN DIGITAL SKY SURVEY QUASAR LENS SEARCH. VI. CONSTRAINTS ON DARK ENERGY AND THE EVOLUTION OF MASSIVE GALAXIES
Masamune Oguri, Naohisa Inada, Michael A. Strauss, Christopher S. Kochanek, Issha Kayo, Min-Su Shin, Tomoki Morokuma, Gordon T. Richards, Cristian E. Rusu, Joshua A. Frieman, Masataka Fukugita, Donald P. Schneider, Donald G. York, Neta A. Bahcall, Richard L. White
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41. PeV-scale supersymmetry from new inflation
Kazunori Nakayama, Fuminobu Takahashi
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42. Size and velocity-dispersion evolution of early-type galaxies in a Lambda cold dark matter universe
Carlo Nipoti, Tommaso Treu, Alexie Leauthaud, Kevin Bundy, Andrew B. Newman, Matthew W. Auger
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43. THE SLOAN DIGITAL SKY SURVEY QUASAR LENS SEARCH. V. FINAL CATALOG FROM THE SEVENTH DATA RELEASE
Naohisa Inada, Masamune Oguri, Min-Su Shin, Issha Kayo, Michael A. Strauss, Tomoki Morokuma, Cristian E. Rusu, Masataka Fukugita, Christopher S. Kochanek, Gordon T. Richards, Donald P. Schneider, Donald G. York, Neta A. Bahcall, Joshua A. Frieman, Patrick B. Hall, Richard L. White
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44. Detectability of high-redshift superluminous supernovae with upcoming optical and near-infrared surveys
Masaomi Tanaka, Takashi J. Moriya, Naoki Yoshida, Ken'ichi Nomoto
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45. Modeling of weak-lensing statistics. I. Power spectrum and bispectrum
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46. The Romelsberger index, Berkooz deconfinement, and infinite families of Seiberg duals
Matthew Sudano
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47. Modeling of weak-lensing statistics. II. Configuration-space statistics
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48. Self-shielding effect of a single phase liquid xenon detector for direct dark matter search
A. Minamino, K. Abe, Y. Ashie, J. Hosaka, K. Ishihara, K. Kobayashi, Y. Koshio, C. Mitsuda, S. Moriyama, M. Nakahata, Y. Nakajima, T. Namba, H. Ogawa, H. Sekiya, M. Shiozawa, Y. Suzuki, A. Takeda, Y. Takeuchi, K. Taki, K. Ueshima, Y. Ebizuka, A. Ota, S. Suzuki, H. Hagiwara, Y. Hashimoto, S. Kamada, M. Kikuchi, N. Kobayashi, T. Nagase, S. Nakamura, K. Tomita, Y. Uchida, Y. Fukuda, T. Sato, K. Nishijima, T. Maruyama, D. Motoki, Y. Itow, Y. D. Kim, J. I. Lee, S. H. Moon, K. E. Lim, J. P. Cravens, M. B. Smy
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49. Energy deposition by weakly interacting massive particles: a comprehensive study
C. Evoli, M. Valdes, A. Ferrara, N. Yoshida
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50. New air fluorescence detectors employed in the Telescope Array experiment
H. Tokuno, Y. Tameda, M. Takeda, K. Kadota, D. Ikeda, M. Chikawa, T. Fujii, M. Fukushima, K. Honda, N. Inoue, F. Kakimoto, S. Kawana, E. Kido, J. N. Matthews, T. Nonaka, S. Ogio, S. Okuda, S. Ozawa, H. Sagawa, N. Sakurai, T. Shibata, A. Taketa, S. B. Thomas, T. Tomida, Y. Tsunesada, S. Udo, T. Abu-Zayyad, R. Aida, M. Allen, R. Anderson, R. Azuma, E. Barcikowski, J. W. Belz, D. R. Bergman, S. A. Blake, R. Cady, B. G. Cheon, J. Chiba, E. J. Cho, W. R. Cho, H. Fujii, T. Fukuda, D. Gorbunov, W. Hanlon, K. Hayashi, Y. Hayashi, N. Hayashida, K. Hibino, K. Hiyama, T. Iguchi, K. Ikuta, T. Ishii, R. Ishimori, D. Ivanov, S. Iwamoto, C. C. H. Jui, O. Kalashev, T. Kanbe, K. Kasahara, H. Kawai, S. Kawakami, H. B. Kim, H. K. Kim, J. H. Kim, J. H. Kim, K. Kitamoto, K. Kobayashi, Y. Kobayashi, Y. Kondo, K. Kuramoto, V. Kuzmin, Y. J. Kwon, S. I. Lim, S. Machida, K. Martens, J. Martineau, T. Matsuda, T. Matsuura, T. Matsuyama, I. Myers, M. Minamino, K. Miyata, H. Miyauchi, Y. Murano, T. Nakamura, S. W. Nam, M. Ohnishi, H. Ohoka, K. Oki, D. Oku, A. Oshima, I. H. Park, M. S. Pshirkov, D. Rodriguez, S. Y. Roh, G. Rubtsov, D. Ryu, A. L. Sampson, L. M. Scott, P. D. Shah, F. Shibata, H. Shimodaira, B. K. Shin, J. I. Shin, T. Shirahama, J. D. Smith, P. Sokolsky, T. J. Sonley, R. W. Springer, B. T. Stokes, S. R. Stratton, T. Stroman, S. Suzuki, Y. Takahashi, M. Takita, H. Tanaka, K. Tanaka, M. Tanaka, G. B. Thomson, P. Tinyakov, I. Tkachev, S. Troitsky, K. Tsutsumi, Y. Tsuyuguchi, Y. Uchihori, H. Ukai, G. Vasiloff, Y. Wada, T. Wong, M. Wood, Y. Yamakawa, H. Yamaoka, K. Yamazaki, J. Yang, S. Yoshida, H. Yoshii, R. Zollinger, Z. Zundel
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Michael Loewenstein, Alexander Kusenko
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52. Improved limits on short-wavelength gravitational waves from the cosmic microwave background
Irene Sendra, Tristan L. Smith
Physical Review D, **85**, 123002, 2012

53. Search for nucleon decay into charged antilepton plus meson in Super-Kamiokande I and II
H. Nishino, K. Abe, Y. Hayato, T. Iida, M. Ikeda, J. Kameda, Y. Koshio, M. Miura, S. Moriyama, M. Nakahata, S. Nakayama, Y. Obayashi, H. Sekiya, M. Shiozawa, Y. Suzuki, A. Takeda, Y. Takenaga, Y. Takeuchi, K. Ueno, K. Ueshima, H. Watanabe, S. Yamada, S. Hazama, I. Higuchi, C. Ishihara, H. Kaji, T. Kajita, K. Kaneyuki, G. Mitsuka, K. Okumura, N. Tanimoto, F. Dufour, E. Kearns, M. Litos, J. L. Raaf, J. L. Stone, L. R. Sulak, M. Goldhaber, K. Bays, J. P. Cravens, W. R. Kropp, S. Mine, C. Regis, M. B. Smy, H. W. Sobel, K. S. Ganezer, J. Hill, W. E. Keig, J. S. Jang, J. Y. Kim, I. T. Lim, J. B. Albert, K. Scholberg, C. W. Walter, R. Wendell, T. Ishizuka, S. Tasaka, J. G. Learned, S. Matsuno, Y. Watanabe, T. Hasegawa, T. Ishida, T. Ishii, T. Kobayashi, T. Nakadaira, K. Nakamura, K. Nishikawa, Y. Oyama, K. Sakashita, T. Sekiguchi, T. Tsukamoto, A. T. Suzuki, A. Minamino, T. Nakaya, M. Yokoyama, Y. Fukuda, Y. Itow, T. Tanaka, C. K. Jung, G. Lopez, C. McGrew, C. Yanagisawa, N. Tamura, Y. Idehara, M. Sakuda, Y. Kuno, M. Yoshida, S. B. Kim, B. S. Yang, H. Okazawa, Y. Choi, H. K. Seo, Y. Furuse, K. Nishijima, Y. Yokosawa, M. Koshiba, Y. Totsuka, M. R. Vagins, S. Chen, Y. Heng, J. Liu, Z. Yang, H. Zhang, D. Kielczewska, K. Connolly, E. Thrane, R. J. Wilkes
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54. The Einstein Toolkit: a community computational infrastructure for relativistic astrophysics
Frank Loeffler, Joshua Faber, Eloisa Bentivegna, Tanja Bode, Peter Diener, Roland Haas, Ian Hinder, Bruno C. Mundim, Christian D. Ott, Erik Schnetter, Gabrielle Allen, Manuela Campanelli, Pablo Laguna
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55. Cosmic microwave background bispectrum from the lensing-Rees-Sciama correlation reexamined: Effects of nonlinear matter clustering
Veronika Junk, Eiichiro Komatsu
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56. THE FIRST SYSTEMATIC SURVEY FOR Ly alpha EMITTERS AT z=7.3 WITH RED-SENSITIVE SUBARU/SUPRIME-CAM
Takatoshi Shibuya, Nobunari Kashikawa, Kazuaki Ota, Masanori Iye, Masami Ouchi, Hisanori Furusawa, Kazuhiro Shimasaku, Takashi Hattori
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57. ANALYSIS OF THE EARLY-TIME OPTICAL SPECTRA OF SN 2011fe IN M101
J. T. Parrent, D. A. Howell, B. Friesen, R. C. Thomas, R. A. Fesen, D. Milisavljevic, F. B. Bianco, B. Dilday, P. Nugent, E. Baron, I. Arcavi, S. Ben-Ami, D. Bersier, L. Bildsten, J. Bloom, Y. Cao, S. B. Cenko, A. V. Filippenko, A. Gal-Yam, M. M. Kasliwal, N. Konidaris, S. R. Kulkarni, N. M. Law, D. Levitan, K. Maguire, P. A. Mazzali, E. O. Ofek, Y. Pan, D. Polishook, D. Poznanski, R. M. Quimby, J. M. Silverman, A. Sternberg, M. Sullivan, E. S. Walker, Dong Xu, C. Buton, R. Pereira
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58. CLASSICAL NOVAE IN ANDROMEDA: LIGHT CURVES FROM THE PALOMAR TRANSIENT FACTORY AND GALEX
Yi Cao, Mansi M. Kasliwal, James D. Neill, S. R. Kulkarni, Yu-Qing Lou, Sagi Ben-Ami, Joshua S. Bloom, S. Bradley Cenko, Nicholas M. Law, Peter E. Nugent, Eran O. Ofek, Dovi Poznanski, Robert M. Quimby
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59. Unified Description of Nambu-Goldstone Bosons without Lorentz Invariance
Haruki Watanabe, Hitoshi Murayama
Physical Review Letters, **108**, 251602, 2012

60. CP-violating CFT and trace anomaly
Yu Nakayama
Nuclear Physics B, **859**, 288, 2012

61. NIR Spectroscopy of Star-Forming Galaxies at z similar to 1.4 with Subaru/FMOS: The Mass-Metallicity Relation
Kiyoto Yabe, Kouji Ohta, Fumihide Iwamuro, Suraphong Yuma, Masayuki Akiyama, Naoyuki Tamura, Masahiko Kimura, Naruhisa Takato, Yuuki Moritani, Masanao Sumiyoshi, Toshinori Maihara, John Silverman, Gavin Dalton, Ian Lewis, David Bonfield, Hanshin Lee, Emma Curtis Lake, Edward Macaulay, Fraser Clarke
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14 Outreach and Public Communications

The Kavli IPMU continues to convey the importance and pleasure of our research on physics and mathematics of the universe to general public through a variety of outreach programs.

Science Events and Public Lectures in JFY 2012

April	: The 6th ICRR-Kavli IPMU Joint Public Lecture
May	: Kavli IPMU Naming Commemorative Public Lecture
June	: The 1st Science Café 2012 at Tamarokuto Science Center
July	: The 2nd Science Café 2012 at Tamarokuto Science Center / Science Program for High School Students
September	: The 3rd Science Café 2012 at Tamarokuto Science Center
October	: 2012 Open House on the Kashiwa Campus of the University of Tokyo
November	: The 7th ICRR-Kavli IPMU Joint Public Lecture / Special Public Lecture by 2011 Nobel Laureate in Physics, Brian Schmidt / The Six WPI Research Center Joint Symposium for High School Students
February	: Annual Meeting of the American Association for the Advancement of Science (AAAS)
March	: Science & Technology Festa 2013 / Public Lecture Sponsored by the FIRST Murayama Project

Kavli IPMU Naming Commemorative Public Lecture

Upper: Roger Blandford, giving a lecture.
Lower: Hitoshi Murayama, giving a lecture.

On May 10, the Kavli IPMU naming commemorative public lecture, "Mystery of Black Holes and Neutrinos" was held at the Ito Hall on the University Tokyo's Hongo Campus.

The public lecture was opened with two short remarks by Mr. Fred Kavli, Founder and Chairman of The Kavli Foundation, and by Dr. Robert Conn, President of The Kavli Foundation. Then, Kavli IPMU Director Hitoshi Murayama gave a lecture entitled "Are We Born from Neutrinos?" and Roger Blandford, Director of the Kavli Institute for Particle Astrophysics and Cosmology, Stanford University, spoke on "Black Holes: End of Time or a New Beginning?" The lecture was well attended, with about 350 participants.

ICRR-Kavli IPMU Joint Public Lectures

The Kavli IPMU and ICRR (Institute for Cosmic Ray Research, The University of Tokyo) jointly organized annual public lectures in Spring and Autumn.

On April 14, 2012, the 6th ICRR-Kavli IPMU Joint Public Lecture entitled “Decoding the Mystery of the Universe” was held in Kashiwa City.

Professor Takaaki Kajita, ICRR Director and a Kavli IPMU Principal Investigator, gave the opening address. Then, ICRR Professor Masahiro Teshima gave the first lecture on “Probing the Extreme Universe with High Energy Gamma Rays”.

Kavli IPMU Professor Hiroshi Karoji spoke on the SuMIRe Project entitled “When Sumire (Violet) Flowers Come Out”, as the second lecture.

On Nobember 10, the 7th ICRR-Kavli IPMU Joint Public Lecture entitled “Approaching the Mystery of the Universe” was held at the Koshiba Hall on the University of Tokyo’s Hongo Campus. This lecture was also regarded as an event in cooperation with Japan National Universities FESTA 2012.

Masato Shiozawa, an ICRR Associate Professor as well as a Kavli IPMU Scientist, spoke on, “Probing the World of Elementary Particles and the Universe with the Nuetrinos”, and Naoshi Sugiyama, a Professor at Nagoya University and Principal Investigator at the Kavli IPMU, spoke on, “Darkness Dominates the Universe”.

Hiroshi Karoji, giving a lecture.


Naoshi Sugiyama, giving a lecture.

Science Café 2012 at Tamarokuto Science Center


Sadanori Okamura, giving a lecture.

The Kavli IPMU and Tamarokuto Science Center in Tokyo held a series of “Science Café 2012” lectures under the joint sponsorship. These lectures were conducted with mutual interaction between scientists and audience.

Sadanori Okamura (Professor at Hosei University; former Director of the Todai Institutes for Advanced Study) gave the first lecture, entitled “The Baryonic Universe”, on June 30.

Naoki Yoshida (Professor at Department of Physics, The University of Tokyo and Kavli IPMU Senior Scientist) gave the second lecture entitled “When the Universe Was Filled with Light”, on July 7.

Tomoyuki Abe (Kavli IPMU Assistant Professor) gave the third lecture entitled “Mathematics from Figures – A Small Journey to Three Wonder Worlds of Langlands” on September 8.

Every time, the audience broadly ranging from junior highschool students to septuagenarians actively asked questions, and Science Café 2012 was a great success.


Naoki Yoshida, giving a lecture.


Tomoyuki Abe, giving a lecture.

Summer Science Program for High School Students

The Kavli IPMU organized summer science program "Look into the Universe" for high school students on July 28, at the University Tokyo's Kashiwa Campus. This program consisted of a cosmology lecture by Eiichiro Komatsu (Director of the Department of Physical Cosmology, Max-Planck Institute for Astrophysics and Kavli IPMU Visiting Senior Scientist) and remorte lectures via video conference system from the Hawaii Observatory of the National Astronomical Observatory of Japan and XMASS facility of the Kavli IPMU's Kamioka Branch.

Eiichiro Komatsu, giving a lecture to High School Students.

Group Photo: Students and Kavli IPMU Staff

2012 Open House on the Kashiwa Campus of the University of Tokyo

An annual open house on the Kashiwa Campus of the University of Tokyo was held on October 26 and 27, 2012. During the two days more than 7,000 people visited the Kashiwa Campus in total.

Among them, more than 1,700 people visited the Kavli IPMU Building, where attractive programs consisting of Guided Building Tours, a Digital Space Theater presented by graduate students utilizing a 4-Dimensional Digital Universe Viewer "Mitaka" released by the National Astronomical Observatory of Japan, a 3-D movie "Story of the Origins of the Universe" (produced by Sony ExploraScience, supervised by the Kavli IPMU), astronomy quiz sections, and experiencing the Miura-Ori (the Miura map fold, special technique for folding used on some solar panel arrays; quoted from Weblio), were provided.

On the second day, October 27, three Kavli IPMU scientists delivered public lectures, which were all well-attended.

Hirosi Ooguri, Kavli IPMU Principal Investigator, spoke on "What is Gravity?" in the Kavli IPMU lecture hall. Hitoshi Murayama, Kavli IPMU Director, gave a lecture entitled "Higgs: Tightly Packed Mysterious Particles Filling the Universe" in the campus-wide Special Public Lectures held at the FS Hall. This lecture was also seen at the Kavli IPMU lecture hall through

Hirosi Ooguri, giving a lecture.

Special Public Lecture by Hitoshi Murayama at the FS Hall

live streaming video. There were large audiences at both places, and a Q&A was conducted connecting both places.

As an event related to the open house, 2012 Kashiwanoha Academia Lecture II was held at the Sawayaka Chiba Kenmin Plaza (Plaza for Citizens of Chiba Prefecture), which is located near the campus, and Shinji Mukohyama, Kavli IPMU Associate Professor, gave a lecture entitled "String Theory and a Universe with More Than Four Dimensions".

Shinji Mukohyama, giving a lecture

Little Scientist

Guide Tour of the Kavli IPMU Building

Special Public Lecture by 2011 Nobel Laureate in Physics, Brian Schmidt

On November 19, 2012, three research centers of the University of Tokyo, the Kavli IPMU, the Research Center for the Early Universe, and the Institute of Astronomy jointly hosted a special public lecture "The Accelerating Universe" delivered by Brian Schmidt, 2011 Nobel Laureate in Physics, at the Yasuda auditorium on the University of Tokyo's Hongo campus.

Though the lecture was given late in the afternoon on a Monday, the Nobel Laureate's lecture attracted an audience of 650, including many high school and university students, who joined after school hours. The audience enjoyed Professor Schmidt's lecture, which was given in English, with simultaneous interpretation provided in Japanese.

Brian Schmidt, giving a lecture.

The Six WPI Research Center Joint Symposium for High School Students

On November 24, 2012, a Joint Symposium of the six WPI research centers entitled "WPI High School Outreach Program: Inspiring Insights into Pioneering Scientific Research" was held at the International Congress Center Tsukuba Epochal, hosted by the National Institute for Materials Science's MANA (International Center for Materials Nanoarchitectonics), and co-hosted by other 5 WPI centers. The audience of about 600 comprised mostly high-school students invited from Ibaraki and Chiba Prefectures, with some other participants as well.

Kevin Bundy, speaking with a high school student.

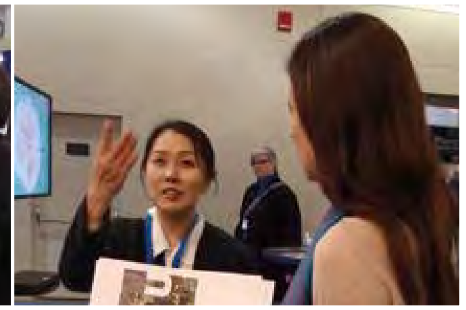
From the Kavli IPMU, Assistant Professor Kevin Bundy spoke on "How Galaxies Are Formed?" in English with simultaneous interpretation in Japanese. He explained the mysteries of the galaxies and the universe, and also introduced his own research.

After the symposium program was over, all the lecturers were present at the poster presentation space, and they communicated with the attendees. Kevin Bundy was surrounded by a number of high school students.

Annual Meeting of the American Association for the Advancement of Science (AAAS)

The six WPI institutes including the Kavli IPMU jointly participated in the "Annual Meeting of the American Association for the Advancement of Science (AAAS) 2013" held on February 14 - 18 in Boston, USA. For 3 days during the Meeting, February 15 - 17, the six WPI institutes hosted the WPI booth as part of the Japan pavilion organized by the Japan Science and Technology Agency (JST). More than 1,000 people visited the Japan pavilion over the three days. Kavli IPMU staff members explained the research activities and researchers' life at the Kavli IPMU to visitors to the booth.

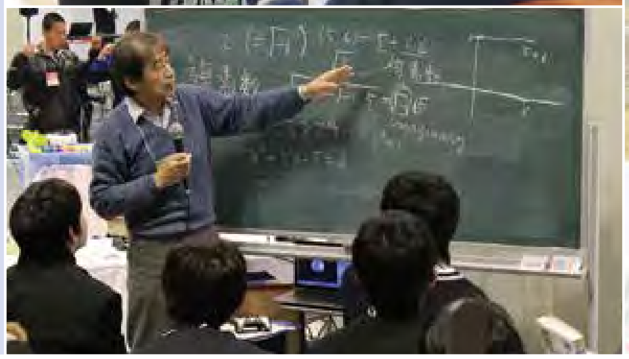
In a scientific symposium entitled "Tiny But Mighty: Neutrinos and the New Frontiers of Science," Kavli IPMU Professor Chang Kee Jung talked on "The Challenging Art of Creating and Catching Human-Made Neutrinos." Also in another scientific symposium entitled "Neutrinos: Nature's Smallest Surprises," Kavli IPMU Professor Mark Vagins talked on "Astronomical Neutrinos".



Science & Technology Festa 2013

On March 16 and 17, 2013, the "Science and Technology Festa 2013" was held at the Kyoto Pulse Plaza. Science and Technology Festa is an event held under the auspices of the Cabinet Office of the Japanese Government and other governmental and public organizations, aiming to enhance people's interests, in particular those of young generations that bear the future, in science and technology. The six WPI centers jointly exhibited their research activities.

IPMU ran an entire single booth. Graduate students guided audience to a virtual space tour "Digital Space Theater." Hitoshi Murayama, Director of Kavli IPMU and Kyoji Saito, Professor of Kavli IPMU, answered plenty of questions by high school students in the program "Question Time." A 3-D movie "Story of Origins of the Universe" (produced by Sony ExploraScience, supervised by the Kavli IPMU) attracted a lot of the audience.



Public Lecture Sponsored by the FIRST Murayama Project

On March 24, 2013, Kavli IPMU public lecture entitled “Challenging the Mystery of the Universe - The Wonder That We Exist Here” was held at the Ito Hall on the Hongo Campus of the University of Tokyo. This lecture was sponsored by the FIRST (Funding Program for World-Leading Innovative R&D on Science and Technology) Outreach Program for the Murayama Project (Kavli IPMU Director Murayama is a core researcher), and gathered an audience of 450 people, including 200 high school students.

The program consisted of two lectures entitled “From Stardust to the Earth” by Professor Eiichiro Kokubo of the National Astronomical Observatory of Japan, and “Why Do We Exist in the Universe?” by Director Murayama. Following these lectures, Azusa Minamizaki, a Project Researcher belonging to the Public Relations Group, General Affairs and Planning Department of the University of Tokyo, facilitated a panel discussion entitled “The Wonder That We Exist Here.”

This public lecture was broadcasted over the internet and many people enjoyed it real time.

Hitoshi Murayama, giving a lecture.

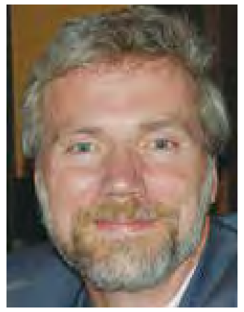
Panel discussion: from right to left, Eiichiro Kokubo, Hitoshi Murayama, Azusa Minamizaki, and high school students.

IPMU NEWS / Kavli IPMU NEWS

Four issues of the IPMU NEWS (Kavli IPMU NEWS from No.18) have been published in JFY2012.

Ask a Scientist

A series of “Ask a Scientist” video clips is shown to the public on the Kavli IPMU website. They explain scientific terms in about one minute. Seven new video clips have been released in JFY 2012.



Direct detection of Dark Matter
Kai Martens

Double beta decay
Alexandre Kozlov

Gravity theory
Emir Gumrukcuoglu

Higgs boson
Shigeki Matsumoto

Subaru ultra-wide-field imaging observatory
Masamune Oguri

Path integral
Todor Milanov

Subaru PFS project
Hajime Sugai

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