April 2014–March 2015

Kavli IPMU

ANNUAL REPORT 2014

THE UNIVERSITY OF TOKYO

KAVLI IPMU INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE

UTIAS 東京大学国際高等研究所 THE UNIVERSITY OF TOKYO INSTITUTES FOR ADVANCED STUDY

wpi World Premier International Research Center Initiative

KAVLI IPMU

Editors
Tomiyoshi Haruyama (Chair), Chiaki Hikage, Nobuhiko Katayama
Kavli Institute for the Physics and Mathematics of the Universe
UTIAS, The University of Tokyo
5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8583, Japan
Tel: +81-4-7136-4940 Fax: +81-4-7136-4941
http://www.ipmu.jp/

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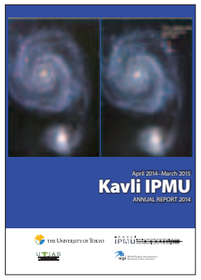
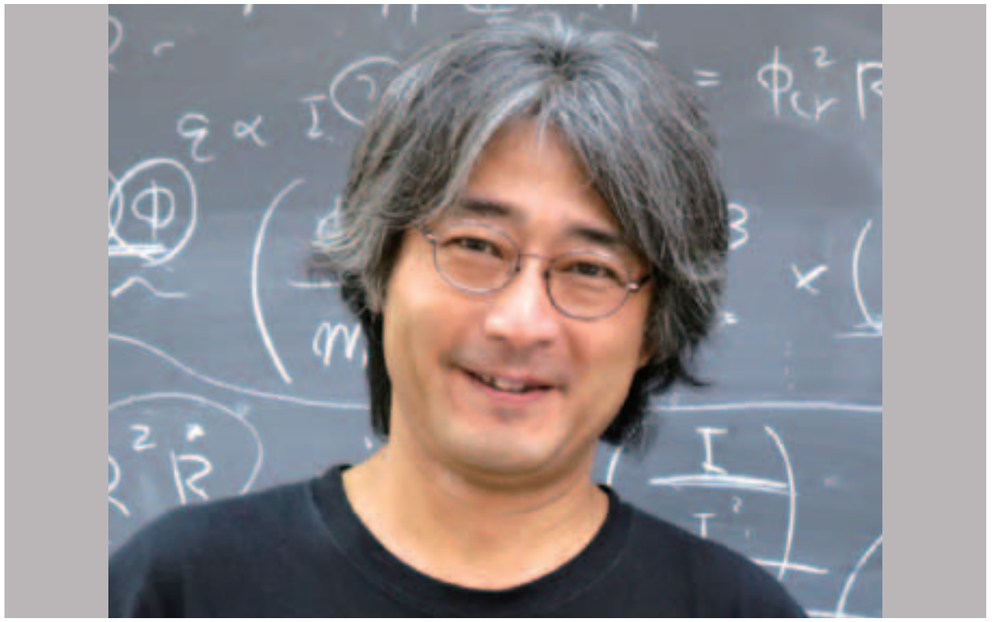


On the cover: M51 Galaxy before (left) and after (right) the eruption of SN 2011dh. The image on the left was taken in 2009, and on the right on July 8th, 2011 (Image credit: Conrad Jung).

FOREWORD



Hitoshi Murayama
Director

It is my great pleasure to present the Kavli IPMU annual report for fiscal year 2014.
The Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU) was founded on October 1, 2007. We proposed to address five basic questions about the Universe: how it began, what it is made of, what its fate is, what its fundamental laws are, and why we exist in it.

We do so by combining mathematics, physics, and astronomy, employing accelerator-based experiments, underground experiments, and observations at telescopes. This Institute literally started from scratch, but now has grown to a size of about 150 people on site including graduate students and support staff.

In 2014, we advanced four missions to reinforce the WPI activities: science, fusion, globalization and system reform. I lined up those prominent scientific results in "Research Highlights". "Tea-time" scheme is keeping its important role as the mutual interaction among mathematicians, physicists and astronomers. The established international research environment could be seen in the numbers of application for the post-doctorial positions, the number of nearly 1000 visitors with a half of them coming from abroad, organized highly reputed international workshops and so on. The institute activated system reform in the University. We achieved the first internal cross appointment, and joint appointments from outside.

The Kavli IPMU has been nominated for a 5-year extension as a "highly exceptional case whose achievements are far beyond the very high WPI standard". We proposed an ambitious plan to include statistics in our research, create a new international graduate program, push for new projects such as LiteBIRD, and make sure that the institute will be sustainable. We are looking into an even brighter future!

1 INTRODUCTION

The Kavli IPMU marks the eighth year since it was founded from scratch as one of the initial five WPI (World Premier Institutes Initiative) institutes. The Kavli IPMU is a unique interdisciplinary institute in the world combining mathematics, theoretical and experimental physics, and astronomy. It has now grown to a competitive world-class institute consisting of 255 research members and 42 administrative and research support staffs. Since the quality of our work is well recognized in the community, the Kavli IPMU has been nominated for a 5-year extension, as a "highly exceptional case whose achievements are far beyond the very high WPI standard".

The Kavli IPMU covers a broad range of fields including experimental physics including accelerators, underground, and astronomy, and theoretical research of particle physics, astronomy, string theory, and mathematics. Our faculty members play leading roles in various projects and fields. In the calendar year (CY) 2014, 314 (452 when including WPI-related) papers were published, with a steady increase over the past years (75, 199, 240, 292, 347, 380 from CY2008 to CY2013 including WPI-related papers). Among the WPI papers published in CY2014, the rate of highly cited papers "top 1% of papers" is 19 (6.1%) based on the Web of Science by Thomson Reuters. The impact factor for all of our refereed papers published from the inception to Dec 2014 is the following: the average number of citations per paper is 17.1; 38 papers have over 100 citations and 133 over 50 citations in which review papers are excluded. The Kavli IPMU members also received 11 valuable prizes or awards during. Scientific works by the Kavli IPMU members were covered by media 366 times.

The highlights in our scientific results in FY2014 are summarized below.

- The XMASS collaboration led by Y. Suzuki provided the most stringent direct constraint on bosonic superweakly interacting massive particles (Super-WIMPs) and ruled out the possibility that Super-WIMPs constitute all dark matter in the universe. Their result was published in Physical Review Letters as an Editor's Suggestion.
- The T2K collaboration took the first data with the beam in the antineutrino-enhanced mode to directly search for CP violation through the differences between neutrino and antineutrino oscillations. Our members T. Nakaya and M. Shiozawa lead the T2K experiment and were awarded the Yoji Totsuka prize for the discovery of the final piece of neutrino oscillation from muon neutrinos to electron neutrinos.
- The KamLAND-Zen experiment led by K. Inoue and A. Kozlov searches for neutrinoless double beta dacay in Xenon 136 to provide the world best limit for the effective Majorana neutrino mass. The team succeeded in reducing Ag-110m background and reported the improved upper limit for the effective mass of 140meV to 280meV in Neutrino 2014 conference.
- The EGADS project led by M. Vagins finished the R&D test for studying the effect of dissolving gadolinium salts in a water Cherenkov detector, and steadily progressed toward supernova detection goals. After refurbishing EGADS filtering system, the team has achieved – with dissolved gadolinium – water transparency equivalent to the ultrapure water in SuperKamiokande. This is a major breakthrough to achieve the highest possible efficiency for detecting supernova neutrinos.
- The Kavli IPMU team headed by T. Higuchi is taking initiative of constructing the silicon vertex detector (SVD), which are core parts of the Belle II detector. The SVD assembly techniques carefully developed in the clean room located in the Kavli IPMU building to realize the super-precision vertex detection are so well established that it is referred to as the standard by other institutes.
- The POLARBEAR experiment of which N. Katayama, M. Hazumi and H. Nishino are members has detected CMB B-mode polarization generated from the gravitational lensing effect of large-scale structure. This is a first significant detection of cosmological B-mode signature and a big step for the LiteBIRD experiment, which aims for detecting primordial gravitational wave imprinted on the CMB B-mode polarization. LiteBIRD was selected on "Master Plan 2014" by Science Council of Japan and on one of ten new projects in the roadmap of large research projects 2014 by MEXT.
- H. Murayama, M. Takada, and N. Tamura lead the SuMIRe project, galaxy imaging and spectroscopic survey using a wide-field imaging camera "Hyper-Suprime Cam" (HSC) and multi-object spectrograph "Prime Focus Spectrograph" (PFS) for the Subaru telescope, to aim for uncovering the origin and future of the universe. The imaging survey using HSC has started and the HSC team is working on the science operation using the first year data.
- Astronomers in the Kavli IPMU made a number of important discoveries. The group led by R. Quimby and M. Oguri first discovered the gravitational lens magnifying Type Ia supernova and their work was published in Science. The team led by M. Ishigaki and K. Nomoto obtained a clue on the mass of first stars in the Universe by analyzing the spectrum of the most iron-poor star recently discovered. The group led by G. Folatelli and M. Bersten found evidence of a hot binary companion star predicted in their new theoretical picture of supernovae.
- Pure gravity mediation (PGM) model developed by the group of T. Yanagida and S. Matsumoto has been widely known to be a successful model for physics beyond the standard model. They showed that both the cosmic-ray electron positron anomaly and the excess of antiproton to proton ratio reported by the AMS-02 group can be explained as the decay of wino dark matter predicted in the models.
- Theoretical physicists in the Kavli IPMU are playing dominant roles in developing methods to exactly compute important observables in supersymmetric gauge theories. K. Hori's group obtained exact formula for supersymmetric partition functions in 1D and 2D theories, which are important for string theory as well as quantum field theory.
- Mathematicians in the Kavli IPMU actively work on a variety of subjects in arithmetic, algebraic complex and symplectic geometry and representation theory with deep connections with theoretical physics in particular with the string theory. Y. Toda has been honorably invited to speak in the International Congress of Mathematicians held once every four years. Y. Toda was also awarded the 11th JSPS prize.

During FY2014, we totally held 233 seminars including interdisciplinary seminars of 79 mass-string (MS) seminars and 91 Astronomy-Cosmology-Particle physics (ACP) (Astronomy-Particle physics-Experimental physics-Cosmology (APEC) seminars after October 2014) in total. The Kavli IPMU has started a new CREST project funded by Japan Science and Technology Agency (JST) in collaboration with the Institute of Statistical Mathematics (ISM), U. Tsukuba, and NTT communications. In coming 5 years, a large data amounting 25 trillion pixel data from Subaru telescope is anticipated in the Hyper Suprime-Cam projects, which aim for mapping the dark matter distribution in the universe. We explore the new frontier of astrostatistics combining statistics with astrophysics to analyze the big data. The new research project will provide new synergies between statistics, astronomy, and mathematics. H. Murayama published several papers jointly with a condensed matter physicist. H. Ooguri, in collaboration with a mathematician, made significant progress in understanding how holographic spacetime emerges from information theoretic data on the boundary. Their paper was selected as Editor's suggestion in Physical Review Letters.

The ratio of non-Japanese members among all of researchers is 41% at the end of FY2014. We succeeded in attracting Prof. Mikhail Kapranov from Yale University as our new faculty member. We also held 13 conference/workshops inside the Kavli IPMU. We have 928 (1689) visitors (the numbers in the parentheses take into account multiple visits). Among them, 471 (549) are international. We obtained 766 applicants for our postdoctoral positions and 92% of them are from outside Japan. So far the Kavli IPMU signed 16 cooperative research agreements or memorandum of understanding (MOU), and student exchange is increasing. We obtain the new external funding from JSPS for the program for advancing strategic international networks to accelerate the circulation of talented researchers.

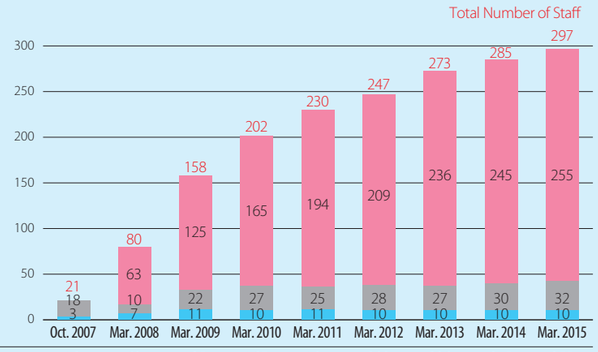
The Kavli IPMU has achieved many reforms including non-traditional tenure positions, merit-based salary system, "nenpo" system, Kavli endowment and naming. Our successful system reforms are expected to spread to the rest of the University and other research institutions to help boost the overall competitiveness of Japan on the global scale. We achieved the first internal cross appointment for Prof. N. Yoshida between the Faculty of Science in UTokyo (60%) and the Kavli IPMU (40%) under a clear job effort contract. We attracted M. Hazumi as a professor on a joint appointment with KEK, who is the PI of CMB polarization experiments of POLARBEAR2 and LiteBIRD.

The Kavli IPMU and Hamamatsu Photonics K.K. established the Endowed Research Unit: Dark side of the Universe. This is the first endowed research unit for the field of fundamental science in UTokyo to strengthen the discussions between researchers in fundamental physics and engineers in the company. K. Nomoto, our project professor, received the title of Hamamatsu Professor.

We have many outreach activities and the total number of audience is more than 4700. As trans-disciplinary activities, we held a public event named "Science Onsen", a Japanese version of science cafe, in Kashiwa open campus and also JST Science Agora. In this event, we held public speech events between our theoretical physicist with a painter and a photographer for exchanging their ideas on the relationship between science and art. These events are very interesting opportunities because such collaboration rarely happens. H. Murayama and H. Ooguri wrote many scientific books and the published number of copies reaches 750,000. H. Ooguri was awarded Kodansha Prize for Science Books for his popular science book.

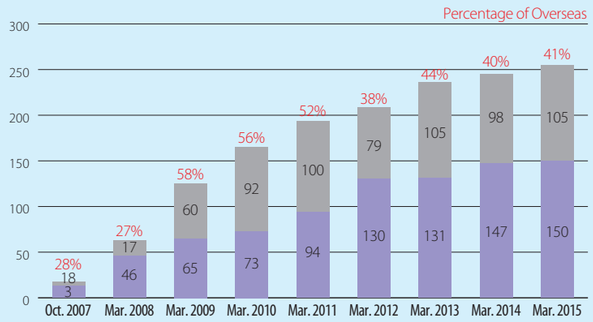
Finally we should mention that Director Murayama delivered a speech titled "Science for peace and development today and tomorrow" at United Nations (UN) Headquarters on the occasion of CERN's 60th anniversary. He remarked that basic scientific research is a true peacemaker for humankind and appealed for the need to make places to unify all people toward common goals of science. He named "The Institute for the Physics and Mathematics of the Universe" to be the place open to anybody irrespective of origins to do research on the mystery of the universe. His speech is broadcast in UN Web TV and spreads the spirit of founding the Kavli IPMU worldwide.

STAFF



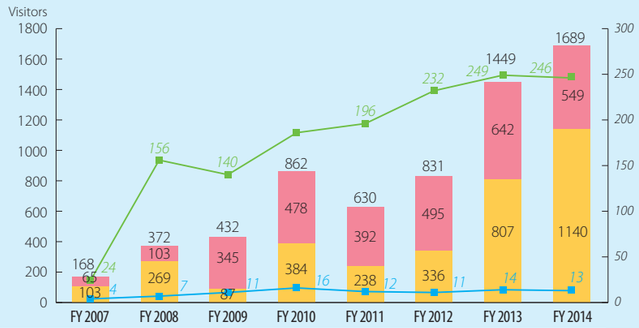
	Oct. 2007	Mar. 2008	Mar. 2009	Mar. 2010	Mar. 2011	Mar. 2012	Mar. 2013	Mar. 2014	Mar. 2015
Researchers	18	63	125	165	194	209	236	245	255
Research Support Staffs	0	10	22	27	25	28	27	30	32
Administrative staff	3	7	11	10	11	10	10	10	10
Total	21	80	158	202	230	247	273	285	297

RESEARCHERS



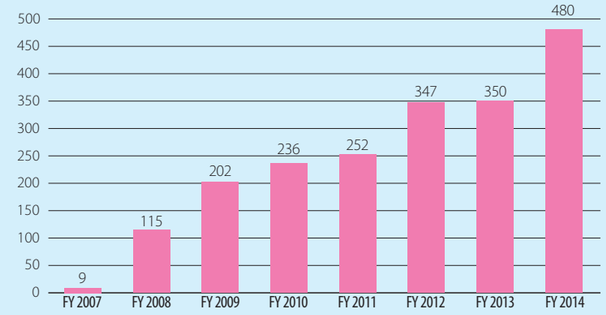
	Oct. 2007	Mar. 2008	Mar. 2009	Mar. 2010	Mar. 2011	Mar. 2012	Mar. 2013	Mar. 2014	Mar. 2015
Overseas	5	17	60	92	100	79	105	98	105
Domestic	13	46	65	73	94	130	131	147	150
% of Overseas	28%	28%	48%	56%	52%	38%	44%	40%	41%
% of Female	0%	2%	5%	6%	5%	2%	5%	5%	6%

RESEARCH ACTIVITIES

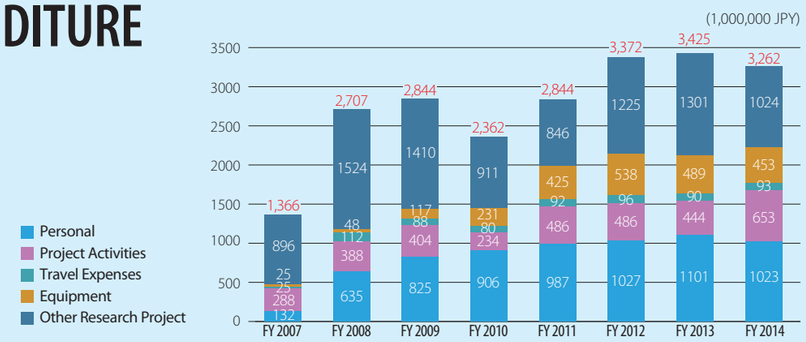


	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Visitors (Overseas)	65	103	345	478	392	495	642	549
Visitors (Domestic)	103	269	87	384	238	336	807	1140
Visitors (Total)	168	372	432	862	630	831	1449	1689
Seminars	24	156	140	186	196	232	249	246
Conferences	4	7	11	16	12	11	14	13

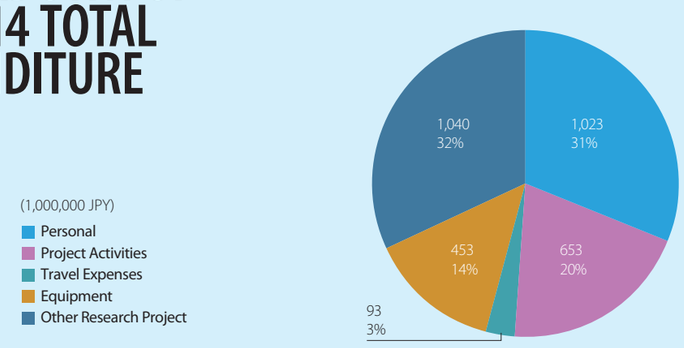
PUBLICATIONS



TOTAL EXPENDITURE



BREAKDOWN OF FY 2014 TOTAL EXPENDITURE



2 NEWS & EVENTS April 2014-March 2015

APRIL

>> Kavli IPMU and Hamamatsu Photonics K.K. established the Endowed Research Unit: Dark side of the Universe
>> Focus week workshop on Hyper-accretion
>> Workshop "Floer and Novikov homology, contact topology and related topics"
>> Press release "Cosmic illusion revealed: Gravitational lens magnifies supernova"
>> Toshiyuki Kobayashi was awarded the Medal with Purple Ribbon
>> Freeman Dyson visited Kavli IPMU
>> The 10th ICRR-Kavli IPMU Joint Public Lectur "Decoding the Mystery of the Universe"
>> Evening of Art and Live Music in Piazza Fujiwara

MAY

>> Hirosi Ooguri was appointed as the Founding Director of the Walter Burke Institute for Theoretical Physics at Caltech
>> Math open house for prospective graduate students

JUNE

>> Press release "Resolved tension between Higgs mass and Supersymmetry" — Editor's Suggestion of the Physical Review Letters —
>> The 7th meeting of the Kavli IPMU external advisory committee
>> Science Café Universe 2014

JULY

>> 2014 Hermann Weyl Prize was awarded to Yuji Tachikawa

AUGUST

>> Free online course "From The Big Bang To Dark Energy" started again in this year
>> Science book prize was awarded to Hirosi Ooguri
>> Minister Ichita Yamamoto toured Ooguri's laboratory at Caltech
>> New survey "MANGA" began mapping nearby galaxies
>> Press release "Space Telescope Witnesses Asteroid Smashup"
>> A Program to encourage Female Students to Study Science: "Listen to and Look into the Universe"
>> Charles Melby-Thompson talked at the Super Science High School Students Fair 2014

SEPTEMBER

>> Press release "A Chemical Signature of First-Generation Very-Massive Stars"
>> Press release "Lurking Bright Blue Star Caught! — The Last Piece of a Supernova Puzzle — "
>> Press release "Most metal-poor star hints at universe's first supernovae"
>> Joint Public Lecture with ISSP "Close Connection between Materials Science and Particle Physics"

OCTOBER

>> CREST funding project to explore the new frontier of ststiatical computational cosmology started
>> Press release "A Warm Dark Matter Search Using XMASS" — Editors' Suggestion of Physical Review Letters —
>> France Córdova, director of National Science Foundation (NSF) visited Kavli IPMU
>> Workshop "Towards quantum primitive form theory"
>> Press release "Explosion of a Low-Mass Helium Star in a Binary— First Evidence of a Hydrogen-deficient Supernova Progenitor — "
>> Kavli IPMU celebrated its 7th anniversary
>> Hitoshi Murayama delivered the speech of the peacemaking power of science at United Nations
>> Workshop on CLASS and MontePython
>> Kashiwa Campus Open House 2014

NOVEMBER

>> Kavli IPMU - RIKEN iTHES - Osaka TSRP symposium "Frontiers of Theoretical Science: Matter, Life and Cosmos"
>> Yuji Tachikawa was awarded the Nishinomiya-Yukawa Memorial Prize
>> Tsuyoshi Nakaya was awarded the 2014 Nishina Memorial Prize
>> The 24th Workshop on General Relativity and Gravitation in Japan (JGRG24)
>> Workshop "Galaxies and Cosmology in Light of Strong Lensing"
>> Kavli IPMU held "Science Onsen (Spa)" in Science Agora 2014
>> The 11th Kavli IPMU-ICRR Joint Public Lecture – Look into the Universe

DECEMBER

>> The fourth annual WPI joint symposium held in Tokyo
>> Santa Claus is coming to Donguri from the Kavli IPMU

JANUARY

>> Press release "Decoding the gravitational evolution of dark matter halos" — Editor's Suggestion of the Physical Review D —
>> Yukinobu Toda was awarded the 11th JSPS Prize
>> Workshop "String Theory in Greater Tokyo"
>> Sixth open meeting for the Hyper-Kamiokande project

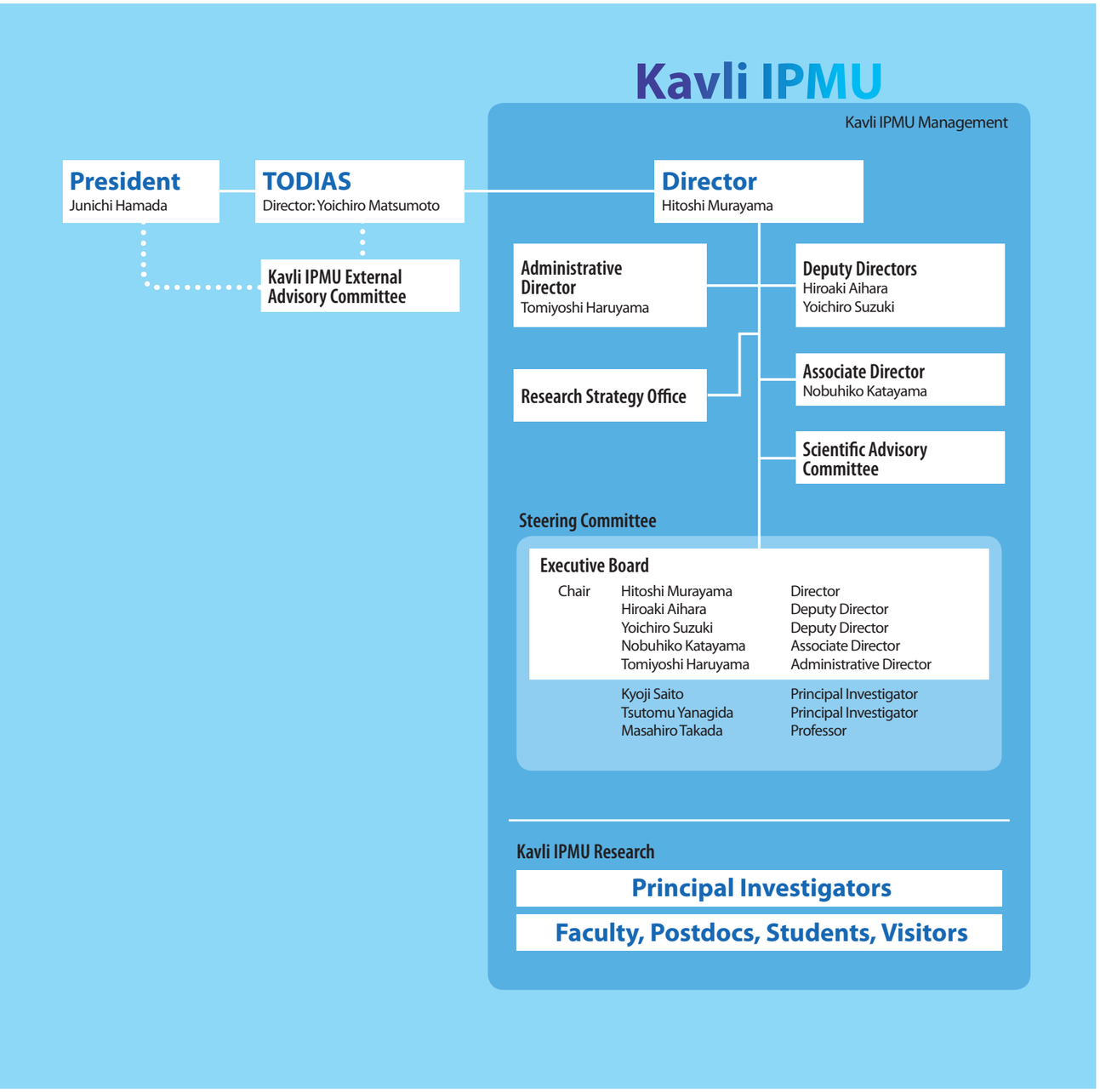
FEBRUARY

>> Workshop "Getting a Grip on Galactic Girths"
>> Sloan Digital Sky Survey opened a new observational data "DR12" to the public
>> WPI institutes jointly participated in AAAS 2015 in San Jose, California

MARCH

>> Eiichiro Komatsu was awarded the 2014 Chushiro Hayashi Prize
>> Kavli IPMU was nominated for a 5-year extension under the WPI program
>> Tsuyoshi Nakaya and Masato Shiozawa were awarded the 6th Yoji Totsuka Prize
>> Workshop on nuPRISM detector
>> Conference "Key Aspects in Exploring Road to Unification (KAERU Conference)"
>> Spring science camp for high school students held at the Kavli IPMU

3 ORGANIZATION



The Kavli IPMU has a rather unique organization. While research is conducted in a flatstructure 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 constitute the Executive Board (EB) and regularly meet 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 planning 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 its objectives.

The Scientific Advisory Committee Members (March 2015)

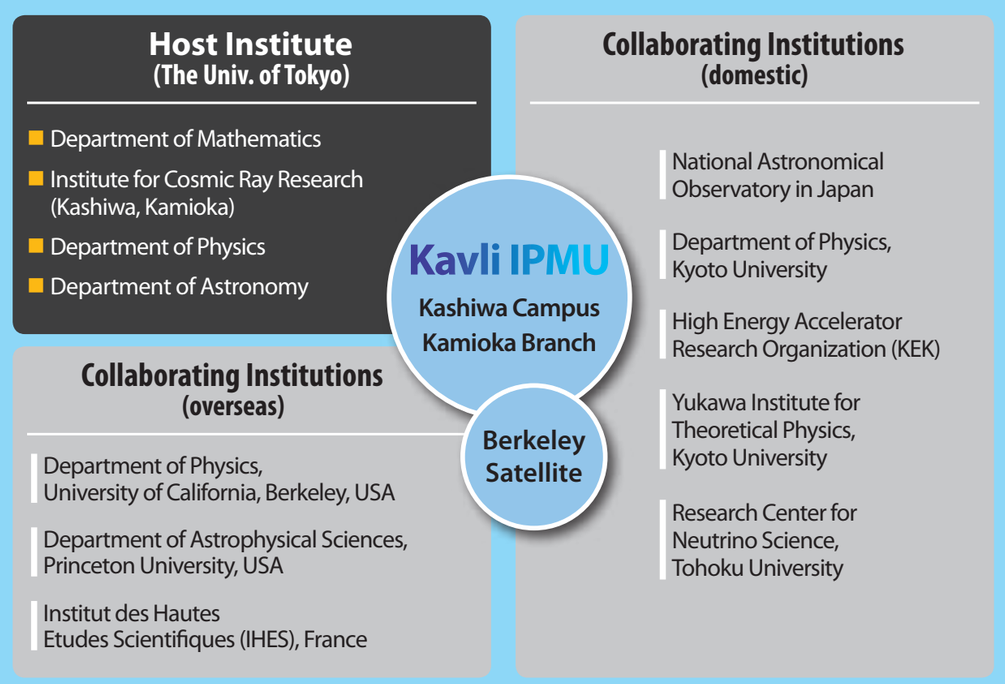
Hiroaki Aihara	U Tokyo, Physics Dept	High Energy Physics
Yoichiro Suzuki	U Tokyo, ICRR	Astroparticle Physics
Nobuhiko Katayama	Kavli IPMU	High Energy Physics
Toshitake Kohno	U Tokyo, Mathematics Dept	Mathematics
Hirosi Ooguri	Caltech	Particle Theory
Kyoji Saito	Kavli IPMU	Mathematics
David Spergel	Princeton U	Astrophysics
Tsutomu Yanagida	Kavli IPMU	Particle Theory

The External Advisory Committee Members (March 2015)

John Ellis	King's College London	Particle Theory
Steven Kahn	SLAC/Stanford U; Chair	Astrophysics
Young-Kee Kim	U Chicago	High Energy Physics
Sadayoshi Kojima	Tokyo Tech	Mathematics
David Morrison	UC Santa Barbara	Mathematics and Physics
Sadanori Okamura	Hosei U	Astronomy
Nigel Smith	SNOLAB	Astroparticle Physics

The Research Strategy Office pursues external funds in order to strengthen the research activities. A university research administrator (URA) was newly hired to start the office activities.

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 underground experiments conducted at the Kamioka underground laboratory. 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]
The Astrophysics Research Consortium [on the Sloan Digital Sky Survey AS3 (“After SDSS III”)]
The Astrophysics Research Consortium [on the Sloan Digital Sky Survey IV]
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 Intermediate Palomar Transient Factory (iPTF)
Steklov Mathematical Institute, Russian Academy of Sciences
Center for Mathematical Sciences, Tsinghua University
The Tata Institute of Fundamental Research
TRIUMF (Canada’s National Laboratory for Particle and Nuclear Physics)
Deutsches Elektronen Synchrotron (DESY)

4 STAFF

Director
Hitoshi Murayama, Particle Theory

Deputy Directors
Hiroaki Aihara, High Energy Physics
Yoichiro Suzuki, Astroparticle Physics

Associate Director
Nobuhiko Katayama, High Energy Physics

Principal Investigators
Hiroaki Aihara (U Tokyo), High Energy Physics
Alexey Bondal (Steklov Math. 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-Mat), Mathematics
Hitoshi Murayama (Kavli IPMU & UC Berkeley), Particle Theory
Masayuki Nakahata (U Tokyo-ICRR), Astroparticle Physics
Mihoko Nojiri (KEK), Particle Theory
Ken'ichi Nomoto (Kavli IPMU), Astronomy
Hirosi Ooguri (Caltech), Mathematical Physics
Kyoji Saito (Kavli IPMU), Mathematics
Henry Sobel (UC Irvine), Astroparticle Physics
David Spergel (Princeton U), Cosmology
Naoshi Sugiyama (Nagoya U), Cosmology
Yoichiro Suzuki (Kavli IPMU), Astroparticle Physics
Tsutomu Yanagida (Kavli IPMU), Particle Theory

Faculty Members
Tomoyuki Abe, Mathematics
Alexey Bondal, Mathematics (2014/08/02 - 2015/02/15)
Kevin Allen Bundy, Astronomy
Masataka Fukugita, Astrophysics
Mark Hartz, Neutrino Physics
Masashi Hazumi, High Energy Physics (from 2014/05/01)
Simeon Hellerman, String Theory
Takeo Higuchi, High Energy Physics
Kentaro Hori, String Theory
Mikhail Kapranov, Mathematics (from 2014/05/16)
Nobuhiko Katayama, High Energy Physics
Satoshi Kondo, Mathematics (till 2014/08/31)
Alexandre Kozlov, Neutrino Physics
Alexie, Solange Leauthaud Harnett, Astrophysics
Kai Martens, Astroparticle Physics
Shigeki Matsumoto, Cosmology
Todor Milanov, Mathematics
Surhud More, Astronomy
Shinji Mukohyama, Cosmology (till 2014/09/30)
Hitoshi Murayama, Particle Theory
Ken'ichi Nomoto, Astronomy
Yasunori Nomura, Particle Theory (from 2015/01/01)
Kyoji Saito, Mathematics
John Silverman, Astronomy
Hajime Sugai, Astronomy
Nao Suzuki, Astrophysics
Yoichiro Suzuki, Astroparticle Physics
Masahiro Takada, Cosmology
Naoyuki Tamura, Astronomy
Yukinobu Toda, Mathematics
Edwin Turner, Astrophysics (2015/03/06 - 03/31)
Mark Vagins, Astroparticle Physics (from 2014/06/16)
Taizan Watari, Particle Theory
Masahito Yamazaki, String Theory (from 2014/08/16)
Tsutomu Yanagida, Particle Theory
Naoki Yasuda, Astronomy
Naoki Yoshida, Astrophysics

Postdoctral Researchers
Amir Babak Aazami, Mathematics
Shamik Banerjee, String Theory (from 2014/04/16)
Melina Bersten, Astronomy (till 2014/09/30)
Jyotirmoy Bhattacharya, String Theory
Biplob Bhattacharya, High Energy Physics
Christophe Bronner, High Energy Physics (from 2014/05/01)
Richard Calland, Neutrino Physics (from 2014/11/02)
Edmond Cheung, Astronomy (from 2014/10/01)
Yu-Chieh Chung, Particle Theory (till 2014/07/31)
Tanmay Neelesh Deshpande, Mathematics
William Donovan, Mathematics (from 2014/11/01)
Gaston Folatelli, Astrophysics (till 2014/09/30)
Dongmin Gang, String Theory (from 2014/10/01)
Song Huang, Astrophysics (from 2014/08/01)
Ran Huo, Particle Theory
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Serguey Petcov (SISSA), Particle Theory (2014/11/13 - 2014/11/30)
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5 RESEARCH HIGHLIGHT

5.1 Unbiased Bases and Critical Points of a Potential

Alexey Bondal*

A part of my research activity in the year 2014 was related to mathematical study of system of mutually unbiased bases. The classification problem of systems of unbiased bases attracted a lot of attention in physics literature. It is considered as one of the basic problem in Quantum Information Theory. Though we study jointly with my collaborator Ilya Zhdanovskiy the subject for several years, we got a serious progress in the year under report.

Our results can be devided in 3 parts. The first part is about categorical interpretation of mutually unbiased bases in terms of representation theory of some algebras, which are obtained by a formal construction called *homotope* from the group algebras of the fundamental groups of relevant graphs. There representation theory is related to the harmonic analysis on graphs. We proved that the derived category of representations of these algebras have canonical semiorthogonal decompositions, which allow to understand the representaion theory much better. We proved coherence of a class of quasi-free algebras (A. Bondal, I. Zhdanovskiy, *Coherence of relatively quasi-free algebras* arXiv:1501.02521), that implies the existence of a suitable abelian category of representations for algebras under consideration. Moreover, the abelian category of representations themselves might be identified with the heart of a glued t-structure. The glueing of t-structures was defined by Beilinson-Bernstein-Deligne in course of the study of perverse sheaves on stratified topological spaces. Thus, our results pave the road to application of the perverse sheaves techniques to the problem of mutually unbiased bases.

We also finished in 2014 our work A. Bondal, I. Zhdanovskiy, *Orthogonal pairs for Lie algebra sl(6)*, IPMU14-0296, IPMU, Kashiwa, Japan, 2014, 89 pp., which continued for several previous years, on proving the existence of 4-dimensional family of mutually unbiased pairs of bases in dimension 6. This is an extremely involved subject that requires a lot of techniques from algebra and algebraic geometry. In algebra, it is about the study of moduli spaces of representations of preprojective algebras, and in geometry we used the technics of elliptic surfaces and automorphisms of varities of general type. It has culminated in the proving the conjecture on the existence that was open for 10 years.

The third part of our work, we apply methods of the symplectic geometry to the classification problem of mutually unbiased bases in its complexified version (A. Bondal, I. Zhdanovskiy, *Symplectic geometry of unbiasedness and critical points of a potential*, arXiv:1507.00081. A complexification of mutually unbiased bases is mutually unbiased systems of orthogonal projectors. We show that the locus of mutually unbiased pairs of systems of orthogonal projectors is an intersection of two Lagrangian subvarieties in the symplectic variety Y, the products of coadjoint orbits. We construct a symplectic open embedding of the cotangent bundle to one of the Lagrangian variety into Y.

In this way we prove that the locus of mutually unbiased pairs of bases is given by critical points of a potential. An explicit formula for the potential was derived and happen to be a Laurent polynomial. If a Laurent polynomial is interpreted as a Landau Ginzburg potential, then its critical points are the object of study in mirror symmetry, where they are related to geometry of the mirror dual variety. The mirror dual variety is defined by the Newton polytope of the Laurent polynomial. We found that in our case, it happened to be the famous Birkhoff-Von Neumann polytope, that is intensively studied in the theory of stochastic matrices and combinatorics. We proved that the mirror toric variety is Fano and has terminal singularities, which implies that various methods of mirror symmetry are relevant for the case under study too.

*Kavli Institute for the Physics and Mathematics of the Universe (WPI), Principal Investigator in Mathematics

5.2 Secondary Polytopes and the Algebra of the Infrared

Mikhail Kapranov

One of my research results in 2014 was to establish a connection between the combinatorial-geometric theory of secondary polytopes on one hand, and, on the other, with the physical approach of analyzing supersymmetric field theories "in the infrared regime" as developed by Gaiotto, Moore and Witten.

Secondary polytopes were introduced in my joint work with Gelfand and Zelevinsky long time ago. For a finite set A of points in the n-space, its secondary polytope $\Sigma(A)$ classifies triangulations of the convex hull Q of A with vertices in A: each vertex of $\Sigma(A)$ corresponds to some particular triangulation. The original motivation behind this construction was purely mathematical: the study discriminants of polynomials in several variables. In this setting, the set A consists of necessarily integer points, labeling various monomials in n variables that are allowed in the polynomials, for example the monomial $x^2y^3z^5$ gives the point (2, 3, 5) and so on. However the construction of the secondary polytope can be performed for any set A of points, integer or not, although at the time, no applications of the non-integer case were known.

In the paper *Algebra of the infrared and secondary polytopes*, arXiv 1408.2673, joint with M. Kontsevich and Y. Soibelman, we have established a relation of this mathematical construction with the approach of Gaiotto, Moore and Witten (their fundamental paper recently appeared as arXiv 1506.04087). In the infrared approximation, the most visible features of a theory are its set of vacua, and the data of (BPS, i.e., partially supersymmetric) solitons transitioning between different vacua. One can label vacua by a set $A = \{w_1, \ldots, w_N\}$ in the complex plane, i.e., in the real 2-space, and, remarkably, the secondary polytope of this A has direct meaning for the physical approach. In the case of the Landau-Ginzburg model given by a superpotential W (a holomorphic function on a complex Kähler manifold) the vacua are the critical points of W, and the w_i are the corresponding critical values. However, one can formulate this for more general theories, not necessarily coming from a potential, by noting that the differences $c_{ij} = w_i - w_j$ are recovered as the central charges of the supersymmetry algebra in the appropriate sectors. This more general point of view was emphasized by Cecotti and Vafa in hep-th/9211097, following the 1978 work of Olive and Witten on such multi-central-charge supersymmetry. Thus, in the new setting, $n = 2$ but the set A no longer consists of integer points.

A central role in the GMW approach is played by a certain Lie algebra of planar "webs". We found a natural mathematical construction and a conceptual explanation of this algebra. It is based on a remarkable *factorization property* of secondary polytopes: each face of $\Sigma(A)$ is itself a product of several other secondary polytopes $\Sigma(A_i)$. This property was known for some time but its significance was not clear. On the other hand, similar factorizable structures have recently (work of Costello, Gwilliam and others) become important in the algebraic approach to quantum field theory, where they express locality properties of the theory. In our setting, factorization leads to a multiplicative (algebra) differential on a certain graded commutative algebra patched out of chain complexes (with some coefficients) of various secondary polytopes. The data of the BPS solitons provide the coefficients. Now, weak (or homotopy) Lie algebras are described by precisely such differentials, with all the higher Jacobi identities packed into one condition $d^2 = 0$ which is, a priori, hard to satisfy. In our case, this condition follows automatically since it is true for the chain complex of any polytope.

So we do get a homotopy Lie algebra g from the fundamental properties of secondary polytopes, and we prove that it is identified with the algebra of webs. Further, there is a relative version (associated with a choice of a point at infinity) which gives an associative algebra R on which g acts by deformations. This is the algebra of "semi-infinite webs". We have proved a result which was not expected by the physicists, namely that g is quasi-isomorphic to the full deformation complex of R (modified so as to preserve the natural triangular structures existing on R).

Thus one can say that secondary polytopes govern a considerable part of the physical approach to the analysis of supersymmetric QFT in 2 dimensions.

5.3 Moduli of Bridgeland Semistable Objects on 3-Folds and Donaldson-Thomas Invariants

Dulip Piyaratne

This article highlights the main results in my joint work with Yukinobu Toda "Moduli of Bridgeland semistable objects on 3-folds and Donaldson-Thomas invariants", arXiv:1504.01177.

Algebraic geometry can be described as the study of geometric objects called algebraic varieties that arise as zero sets of polynomials. A more modern approach in the subject is to study the varieties indirectly via some algebraic objects associated to them. Sheaf theory is such an algebraic tool that encodes both the local and global information of a variety. The main idea of homological algebraic methods is to embed the objects into a more fitting world of complexes, where less information gets lost. In particular, the theory of derived categories provides an efficient algebraic platform to investigate the hidden geometric information of a variety. Some of the recent developments on derived categories were highly influenced by important ideas from Mathematical Physics.

The notion of stability appears in various forms in algebraic geometry and it is fundamental in the construction of certain parameter spaces called moduli spaces of sheaves. The study of D-branes on Calabi-Yau manifolds inspired various mathematical questions and one of them is to find a new categorical stability notion. Motivated by this question, Bridgeland introduced the notion of stability conditions on triangulated categories. It can be interpreted essentially as an abstraction of the usual slope stability for sheaves. However, the category of coherent sheaves does not arise as a heart of a Bridgeland stability condition for higher dimensional smooth projective varieties; so more work is needed. In homological algebra, there is a way to obtain new hearts of t-structures from the known ones by the process called tilting with respect to a torsion pair. Tilting has been extremely successful in constructing stability condition hearts, and it was used by Bridgeland and Arcara-Bertram to construct stability conditions on projective surfaces. Following these ideas, Bayer-Macri-Toda proposed a conjectural construction for any smooth projective threefold, and the problem is reduced to proving an inequality, which the authors call a Bogomolov-Gieseker (BG) type inequality, holds for certain tilt semistable objects. In my joint work with Yukinobu Toda, we introduced the notion of very weak stability conditions on triangulated categories and associated BG type inequalities. We realized the corresponding tilting process nicely describes the known tilting constructions of surfaces and 3-folds. Furthermore, we generalized the formulation of equivalent BG type conjectural inequalities for tilt semistable objects on 3-folds due to Bayer-Macri-Stellari.

One of the crucial implications of having a very weak stability condition is that it enables us to single out certain objects in the derived category which can be parametrised as moduli spaces; more precisely as substacks of Lieblich's algebraic stack. Most interestingly, this notion is extremely useful to realize families of such moduli spaces. In our work, in some sense, we showed that the generic flatness of the hearts and the boundedness of semistable objects in certain very weak stability conditions are preserved under the tilting process. Consequently, assuming the BG type conjectural inequalities for tilt semistable objects, we proved that the moduli stack of Bridgeland semistable objects on 3-folds with a fixed numerical class is a proper algebraic stack of finite type. Moreover, we extended this realization for other stability conditions in certain connected components of the space of stability conditions.

Another area which has a growing interest in Bridgeland stability is on defining new invariants to a variety through the moduli spaces of complexes of sheaves. The Donaldson-Thomas (DT) invariants were originally introduced as counting invariants of holomorphic vector bundles on a Calabi-Yau 3-fold. In the usual algebro-geometric definition, DT theory depends on the choice of stability condition on coherent sheaves and classically it is given by the choice of an ample divisor. We used our study of moduli of Bridgeland semistable objects on 3-folds to define DT invariants counting semistable objects on Calabi-Yau 3-folds satisfying the conjectural BG type inequalities. Also we showed that they are invariant under the deformations of the underlying complex structures. Furthermore, following the constructions of Joyce-Song and Kontsevich-Soibelman on generalized DT invariants, we constructed the DT invariant map from a connected component of the stability manifold to rational numbers.

5.4 Leptogenesis Via Axion Oscillations after Inflation

Kai Schmitz

Why do we see almost no antimatter in the cosmos? This innocent-sounding question represents the basis for one of the biggest puzzles of modern cosmology: the observed asymmetry among baryons and antibaryons in the universe. The standard model (SM) of particle physics unfortunately—or fortunately—fails to provide an explanation for this asymmetry, which, thus, serves as a major indication for new physics. As it turns out, most attempts of explaining the generation of the baryon asymmetry of the universe (BAU) by means of some beyond-the-SM dynamics (such as, e.g., thermal leptogenesis) satisfy the three so-called Sakharov conditions. These conditions require, *inter alia*, charge-parity (*CP*) invariance to be violated. As pointed out in [1] long ago, one is, however, able to circumvent these conditions and still account for the BAU in situations where invariance under charge-parity-time (*CPT*) conjugation is spontaneously broken—which might, e.g., be the case in the early universe in the presence of some homogeneous, time-dependent background field.

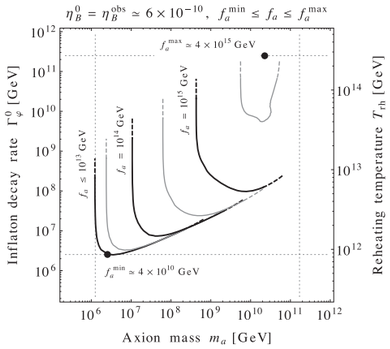

Figure 1: Contours in parameter space along which (for different values of the axion decay constant f_a) the observed baryon asymmetry of the universe can be successfully accounted for by our axion-driven leptogenesis mechanism (see [3] for details).

Triggered by the discovery of the SM Higgs boson at the Large Hadron Collider, this idea has recently received some renewed attention: as proposed in [2], *CPT* may, e.g., be temporarily broken after the end of cosmic inflation while the SM Higgs is slowly relaxing from some large initial field value down to the electroweak vacuum. In [3], we have now taken this idea one step further and generalized the baryogenesis scenario of [2] to the case of an arbitrary "axion field" as it appears in many compactifications of string theory. More concretely, we suppose the existence of some new pseudoscalar field which couples to the divergence of the lepton number current via a dimension-5 operator in the effective theory. At the end of inflation, this pseudoscalar is expected to relax from some large initial field value in its nonperturbative effective potential, which—by virtue of its coupling to the lepton number current—induces an effective chemical potential for leptons and antileptons in the thermal bath. Such a chemical potential results in a bias among the occupation numbers for lepton and antilepton states in thermal equilibrium, which offers a favorable opportunity for baryogenesis via leptogenesis. That is, in the presence of some rapid lepton number-violating interaction, the period of axion relaxation after inflation promises to provide the setting for the generation of a primordial lepton asymmetry (which is then subsequently converted into a baryon asymmetry via electroweak sphaleron processes).

As we are able to demonstrate in [3], this idea can indeed be successfully realized in a minimal extension of the SM: namely within the seesaw model, which actually aims at explaining the smallness of the SM neutrino masses and which features at least two right-handed sterile neutrinos with lepton number-violating Majorana mass terms. It is worth emphasizing that our novel leptogenesis mechanism is more widely applicable and less constrained from cosmological observations than its Higgs-related alternative. Moreover, it differs considerably from the standard scenario of thermal leptogenesis in the sense that it does not rely on the amount of *CP* violation nor on the exact mass spectrum in the neutrino sector. For one thing, it is, thus, compatible with heavy Majorana neutrinos with masses close to the unification scale. For another thing, it does not constrain the masses of the SM neutrinos from above. Our scenario would, hence, emerge as a major alternative to standard thermal leptogenesis in case current or near-future neutrino experiments should turn out to point towards a rather largish SM neutrino mass scale.

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5.5 Searching for Matter/Antimatter Asymmetry with T2K Experiment

Mark Hartz

The Tokai-to-Kamioka (T2K) experiment has been a world leading experiment studying neutrino oscillations and mixing since 2010. Neutrino oscillations, are a phenomenon where one type or "flavor" of neutrino oscillates to another as the neutrino travels through matter or vacuum. The physics of neutrino oscillations are of interest to physicists for two primary reasons. First, oscillations indicate that neutrinos have mass, but these masses are not explained within the Standard Model of particle physics. Hence, neutrino oscillations are a probe of beyond-the-Standard Model physics. Second, neutrinos and their antimatter partners can oscillation differently, so-called CP violation. CP violation is a necessary condition for explaining why the universe consists of matter and not equal parts of matter and antimatter.

The T2K experiment generates a beam of muon neutrinos (ν_μ) at the J-PARC accelerator on the east coast of Japan and measures the content of the neutrino beam 295 km away at the Super-Kamiokande (SK) detector. Last year, T2K published the discovery of the $\nu_\mu \rightarrow \nu_e$ oscillations (Phys. Rev. Lett. 112, 061802 (2014)). T2K also makes precision measurements of the ν_μ survival (Phys. Rev. Lett. 112, 181801 (2014)). By combining the ν_μ and ν_e data observed at SK with measurements of reactor neutrino oscillations, T2K is able to constrain the parameter δ_{CP}, which governs the amount of CP violation in the model of neutrino mixing. If δ_{CP}, has a value that is not an integer multiple of π, then CP violation will be present.

Fig. 1 shows the preference for δ_{CP} values from the T2K data, which was published in Phys. Rev. D 91, 072010 (2015). The data prefer a value near $-\pi/2$ and values near $\pi/2$ are disfavoured at the 90% confidence level. While values at 0 and π are still allowed at the 90% confidence level, it is exciting to see that the value preferred by T2K is a best case scenario for the sensitivity of current experiments. It corresponds to maximum CP violation and minimal interference between the CP violation effect and effects that arise due to the propagation of neutrinos through matter. If this result from T2K holds, the current generation of experiments such as T2K and NOvA have a chance to find strong evidence of CP violation and for the true ordering of the neutrino masses.

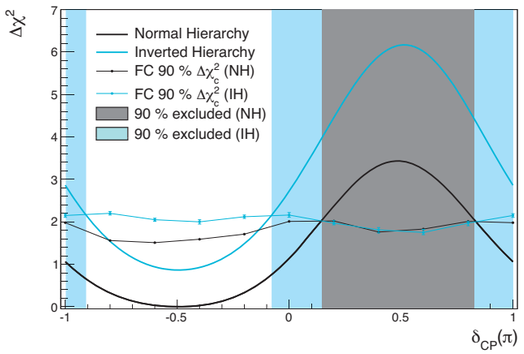

Fig. 1: The $\Delta\chi^2$ from the fit to T2K data as a function of δ_{CP}. The black and blue curves correspond to the normal and inverted neutrino mass orderings. The shaded regions show the values from the normal (black) and inverted (blue) mass orderings at are disfavoured at 90% confidence.

The most compelling evidence for CP violation must come from the measurement of the $\nu_\mu \rightarrow \nu_e$ oscillations for both neutrinos and antineutrinos in a single experiment. In May 2014, T2K switched from operating with a neutrino beam to operating with an antineutrino beam. By summer 2015, the amount of antineutrino data reached almost 40% of the total data collected by T2K. The first search for anti-ν_e appearance at SK found the 3 anti-ν_e candidate events shown in Fig. 2, consistent with the 3.7 events expected based on the value of δ_{CP} preferred by the T2K neutrino data. These results were presented at the European Physical Society High Energy Physics Meeting in July of 2015, to much excitement in the community.

T2K will continue collecting data with both neutrino and antineutrino beam configurations to make more precise measurements of the parameters governing neutrino oscillations, include the δ_{CP} parameter governing CP violation. Now that the NOvA experiment in the United States is running, we expect an exciting period of competition and collaboration that will greatly improve our understanding of neutrino oscillations. The prospects for T2K and combined measurements from T2K and NOvA are described in T2K's recent paper on future sensitivities for neutrino oscillation measurements (Prog. Theor. Exp. Phys. (2015) 043C01).

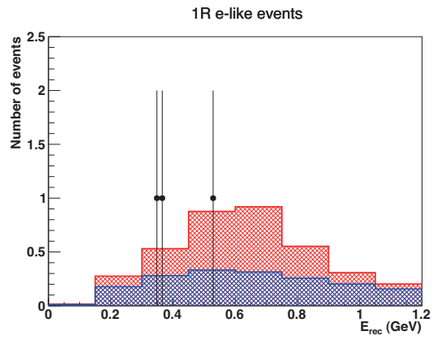

Fig. 2: The reconstructed energy for the three anti-ν_e candidate events (black) and the predicted distributions for the signal (red) and background (blue) events.

The T2K experiment's physics output has not been limited to neutrino oscillation measurements only. The T2K near detectors, located just 280 m from the neutrino source are used to study the interactions of neutrinos on nuclei, which must be well understood to make neutrino oscillation measurements. In the past year, T2K published the first measurements for electron neutrino interactions at T2K's energy range (Phys. Rev. Lett. 113, 241903 (2014) and Phys. Rev. D 91, 112010 (2015)), measurements of interaction rates on iron and hydrocarbon targets (Phys. Rev. D 90 052010) and measurements of charged current quasi-elastic interaction of muon neutrinos (Phys. Rev. D 91, 112002 (2015)). T2K is also using the near detectors to search for neutrino oscillations over a short baseline (Phys. Rev. D 91 051102 (2015)), which could take place if heavy sterile neutrinos exist.

The past year has been an exciting time for the T2K collaboration, as it transitions from its initial goal of discovering $\nu_\mu \rightarrow \nu_e$ oscillations to the search for CP violation in the oscillations of neutrinos. Larger data sets for neutrino and antineutrino beams will be collected in the coming years, opening the door to the search for exciting new results that are essential for understanding the origin of neutrino masses and the very composition of our universe.

5.6 Development of the Belle Ⅱ Silicon Vertex Detector

Takeo Higuchi

In 2018, we are launching the upgraded B-factory experiment, the Belle Ⅱ experiment [1], at KEK, Japan. One of the main motivations of the Belle Ⅱ experiment is to isolate the new physics model, Beyond the Standard Model (BSM) of particle physics, which is based on various hypotheses.

We will produce b, τ, and other particles from the collision of a 7 GeV electron and a 4 GeV positron accelerated by the SuperKEKB accelerator [2]. Although the collision energy is much lower than the expected mass of a BSM particle (> ~1 TeV), the quantum effect allows the BSM particle to virtually appear in the decay process. If the BSM particle exists, the relevant physics parameter should deviate from the pure standard model (SM) prediction by the amount specified in the BSM model. We will pin down the BSM by building a precision deviation matrix from several measurements of the physics parameters.

Because the amplitude of the decay mediated by a BSM particle is very small compared to the SM one, immense collection data is needed to precisely measure the deviation. We will increase the SuperKEKB luminosity from the KEKB by a factor of 40 by squeezing the beam size, reducing the positron beam emittance, and improving the beam pipe structure. After operating for 10 years, 50ab^{-1} data will be accumulated. Figure 1 (left) shows the Belle Ⅱ detector, which is located at the electron–position collision point.

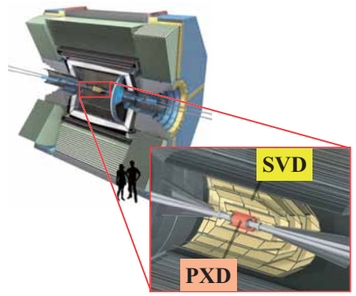

Figure 1: Illustrations of the Belle Ⅱ detector (left) and the pixel detector and SVD (right) located at the center of the Belle Ⅱ detector structure.

The Belle Ⅱ detector consists of seven sub-detectors. The pixel detector and silicon vertex detector determines the precision decay vertex as the impact parameter resolution of a track with $p_T = 2$ GeV/c and $\sigma \sim 40$ μm. The central drift chamber measures the particle momentum and dE/dx, while the time-of-propagation counters and ring-imaging Cherenkov counters separate kaons from pions. The electromagnetic calorimeter measures $e^{\pm}$ and the γ energy. In addition, there is a K_L^0 and muon detector. These improved sub-detectors provide more hermetic and precision measurements than the Belle detector [3]. To accommodate higher event rates and larger data sizes, a faster trigger decision system and a larger throughput data acquisition system are being developed.

Figure 2: Photograph of a dummy ladder for the outermost SVD layer with a slant structure in the forward region (right side of the snapshot). Photograph was taken in our clean room.

The silicon vertex detector (SVD) consists of four cylindrical layers of sensor arrays along the beam direction. Each layer consists of four to sixteen ladders, where the ladder is an array of two to five double-sided silicon detectors (DSSDs), depending on the layer. We designed the SVD with a lantern shape, as shown in Fig. 1 (right) because the legacy cylindrical detector demands more DSSDs as the radial coverage becomes larger. Consequently, the ladder has a slant structure in the forward region (Fig. 2). The DSSD strips facing toward the beam pipe are aligned along the beam direction (except for the innermost SVD layer), while the counter side strips are perpendicular to allow one DSSD to detect a particle hit in two dimensions. The strip signals in the most forward and backward DSSDs are readout by the readout ASIC chips (APV25 chips) located at the end of the ladder. The other strip signals are characteristically readout by the APV25 chips located on the DSSD in order to reduce the capacitive noise by minimizing the signal path length from the strips. The counter side strip signals are transmitted to the chip side by "wrapped" flexible fan-out circuits.

Kavli IPMU became a Belle Ⅱ collaborating institute in 2012, and is currently responsible for the production of the SVD. The R&D of the SVD occurs on the ground floor of the Kavli IPMU building in our clean room (Fig. 2), which has class-1,000 cleanliness. Its temperature and humidity are controlled to 23°C and 50% throughout the year, respectively. Additionally, the clean room has many tools for SVD production: wire bonding (WB) machines, glue dispensing robots, a precision coordinate measuring machine (CMM), a detector readout system, vacuum and compressed air systems, parts-stock desiccators, etc. The facility is fully utilized by the Kavli IPMU researchers and other SVD collaborators affiliated to the University of Tokyo, KEK, Niigata University, Tohoku University, Kyungpook National University (Korea), and Tata Institute of Fundamental Research (India). Below Kavli IPMU's activities and progress with regard to the SVD production are described.

Precision DSSD alignment in the ladder is essential for the high resolution of the decay vertex measurement, The DSSD misalignment from the ladder design value should be minimized less than ~200 μm when the ladder assembly completes. Considering that the maximum length of this very complicated detector design is 65 cm, it is a challenging target. The DSSD strips, fan-out circuits, and APV25 chips are electrically connected by an ultrasonic WB technique. The strip connectivity to the APV25 chips must be more than 99%, which is also demanding. In addition to the high quality targets, consistent high-quality ladders must be produced with less failure because we intend to assemble 20 ladders in 1.5 years with limited spare parts available. To comply with these requirements, we have developed several technical solutions, some of which are described below.

We developed dedicated homemade jigs with a machining precision of ~50 μm at the critical part to handle all ladder components precisely and safely. Reproducible DSSD positioning on the jig was achieved to a precision level of 20 μm using the CMM; other DSSD manipulating jigs were employed in the four axes. The WB efficiency ε > 99% with a sufficient pull strength f > 9 gf against the breaking force was obtained; these values are as high as the CMS experiment at the Large Hadron Collider. Additionally, we determined the set of the WB machine parameters that provide the best performance per bonding component, and a highly reproducible control method of the glue spread was invented to assure no overflow and underflow of the glue from the fabricated components. The glue's viscosity is controlled by pilot gluing and the curing time.

In the summer of the 2014, we assembled an electrically functioning one-DSSD module (called "SM4 module") in order to demonstrate our technical achievements for the ladder assembly procedure. By the end of March 2015, we assembled two mockup ladders using the latest parts at the time; one was a mockup ladder with an electrically functioning DSSD (called the "C1 ladder") and the other was a full mockup ladder to demonstrate the high assembly precision quality (called the "C2 ladder").

We measured the DSSD shifts using the CMM in 2015. All the sensor shifts of the C2 ladder along the beam direction were less than 160 μm. We also carried out the radioactive source test of the electrically functioning DSSDs in the SM4 module and C1 ladder. The cluster position distribution of the hit strips by the β-rays from the 90Sr source on the DSSD plane was clearly demonstrated (Fig. 3).

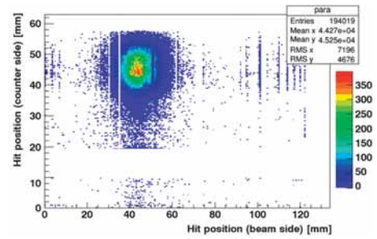

Figure 3: Cluster position distribution of the hit strips by the β-rays from the ^{90}Sr source on the DSSD plane. We used partially functioning parts for this study. Horizontal blank band in the plot corresponds to the strips of the broken APV25 chip.

In early 2016, we plan to start the mass production of the ladders by integrating all the assembly techniques developed so far.

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5.7 Search for Physics beyond Standard Model with KamLAND-Zen

Alexandre Kozlov

During last two decades, results from several neutrino oscillation experiments proved that neutrinos have non-zero mass and this raised the question about nature of neutrinos. Unlike charged leptons, electrically neutral neutrinos can be either Dirac or Majorana particles (their own anti-particles). If the neutrino is a massive Majorana particle, lepton number violating process called neutrinoless double beta ($0\nu\beta\beta$) decay is possible. What would we learn if we could find the $0\nu\beta\beta$ decay? First of all, observation of the $0\nu\beta\beta$ decay would confirm that leptogenesis (Ref. [1,2]) is the answer for the fundamental physics problem - the origin of baryon asymmetry of the Universe (dominance of matter over anti-matter). Moreover, the decay can be used to constrain the absolute neutrino mass in a range not accessible by other experimental techniques. To achieve the above mentioned goals one has to determine experimentally the $0\nu\beta\beta$ decay half-life $T_{½}(0\nu\beta\beta) \sim \text{const}\,[M\,t\,/\,B\,\Delta E]^{½}$, where M, t, B and ΔE is the isotope mass, measurement time, background, and energy region of interest respectively. Based on the half-life result one can determine the effective neutrino mass ($m_{\beta\beta}$) since both are connected by the relation: $[T_{½}(0\nu\beta\beta)]^{-1} \sim (m_{\beta\beta})^2$.

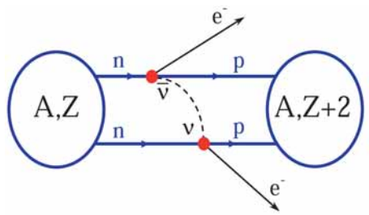

Figure 1

The search for the $0\nu\beta\beta$ decay requires: a highly radio-pure detector located deep underground, and a large amount of isotope with energetically forbidden or highly suppressed ordinary β-decay. Such nuclei undergo transformation via the two neutrino double beta ($2\nu\beta\beta$) decay which is the second order process in the standard model of electroweak interaction. Even the standard $2\nu\beta\beta$ decay is the rarest process that was verified so far for 11 nuclei with a half-life between 10^{19}-10^{24} years. Large scale experiments in world-wide search for the $0\nu\beta\beta$-decay are: GERGA and Majorana (^{76}Ge), CANDLES (^{48}Ca), SNO and CUORE (^{130}Te), EXO-200 and KamLAND-Zen (^{136}Xe). The half-life limit $T_{½}(0\nu\beta\beta) > 2.6 \times 10^{25}$ years at 90%CL set by the KamLAND-Zen collaboration (Ref. [3]) is the best result to date. It has also potential to remain the most sensitive $0\nu\beta\beta$-decay experiment for many years to come.

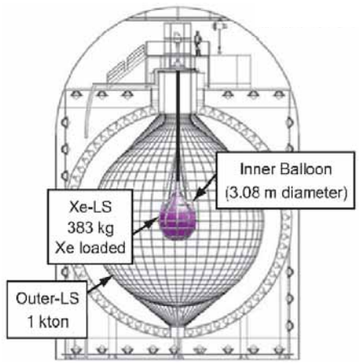

Figure 2

The KamLAND-Zen detector is located in the Kamioka mine, Gifu, Japan. The experiment that started operating from the year 2011 currently has an inner balloon (Ø3.08 m) filled with 13 tons of liquid scintillator loaded with a 383 kg of xenon. The inner balloon keeps Xe-loaded liquid scintillator in central part of the detector where external γ–ray background is the lowest. The KamLAND-Zen has several advantages compared to other large scale $0\nu\beta\beta$-decay experiments, such as: relative simplicity, low cost and scalability without need for major hardware modifications. The scalability is a very important feature that allows us to test gradually all three possible scenarios existing for neutrino masses: quasi-degenerate, inverted and normal mass hierarchy that require 0.1 ton, 1 ton, and 10 tons of a pure ^{136}Xe isotope for verification. During the next 10 years, upcoming ton-scale experiment using ^{136}Xe, called KamLAND2-Zen, will observe the $0\nu\beta\beta$-decay in the effective neutrino mass range ($m_{\beta\beta} \geq 20$ meV) corresponding to the inverted neutrino mass hierarchy or excluding it.

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5.8 Chemical Abundance Patterns of the Most Iron-Poor Stars as Probes of the First Stars in the Universe

Miho Ishigaki

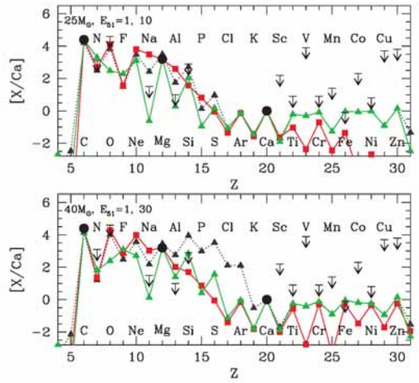
The first stars in the universe were formed almost exclusively from metal-free gases, which are predominantly hydrogen and helium, composed only of nucleosynthetic products from the Big Bang. These stars are thought to have played an important role in ionizing the early universe and to have ejected heavy elements produced during their lifetimes and at their deaths as supernova explosions. Therefore, the birth and death of the first stars should have drastically changed the environment of the early universe, driving subsequent stars and galaxy formation. The magnitude of the first stars' impact depends on the physical properties of the first stars. Most importantly of which are the initial masses, which are not well known.

Since the first stars (if they were sufficiently massive) could have died a long time ago, their observational signatures are limited and often rely on indirect probes. One method to investigate the properties of the first stars is to study nearby very old stars surviving in our Milky Way Galaxy. Because these old stars are usually identified by their very low abundance of elements heavier than helium (less than about 1/10 of the solar composition), they are called metal-poor stars. The chemical composition at the surface of these stars is thought to reflect the nucleosynthetic products of the first stars, and thus, provides useful information about the constraining properties of the first stars. This kind of approach, which is often called "stellar archaeology", is currently one of the most active fields in astronomy thanks to the large datasets of stellar chemical abundances, which recently became available from extensive surveys of our galaxy.

The Sky Mapper Southern Sky survey, which is one survey to hunt for metal-poor stars, recently reported the discovery of the most iron-poor star known to date, SMSS 0313-6707. SMSS 0313-6707 has no detectable iron but shows a large enhancement of carbon. Careful analyses of its spectra revealed that the composition of iron is less than about 1/1,000,000 of the solar value, which is a signature of an object formed from supernova ejecta of the first stars. To identify the signature, which can provide insight into the first stars, we analyzed the peculiar chemical composition of this object.

The figure compares the observed chemical abundances (black points and arrows) and the model predictions for the nucleosynthetic products of the first stars (red, green, and gray lines). Our model predictions for the first stars with initial masses of 25 (top panel) or 40 M_{sun} (bottom panel) explain surprisingly well the extreme chemical composition of this object. Numerical simulations under standard cosmology once predicted that the first stars were extremely massive, up to several hundreds of solar masses because they formed from metal-free gases. In contrast, our results suggest that the progenitor first stars for this object were less massive, around several tens of solar masses, which is well within the range observed in our galaxy today.

The present results for the possible masses of the progenitor first star have important implications on the formation mechanism of the first stars. The ultimate goal of this type of investigation is to constrain the typical masses or distribution of masses of the first stars (initial mass function) by utilizing a much larger sample of metal-poor stars. Ongoing and planned surveys about our galaxy by ground-based telescopes and astronomical satellites strive to identify and obtain the spectra of metal-poor stars as probes of the early universe as well as to elucidate the structure and formation history of our galaxy. A next-generation instrument on the Subaru telescope, the Prime Focus Spectrograph (PFS), is especially well suited to measure the velocity and chemical composition of a large number of metal-poor stars in our galaxy. The present study, which can be applied to the increasing observational data, will be a powerful probe on the nature of the first stars.



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5.9 Measuring Gravitational lensing Using CMB B-mode Polarization by POLARBEAR

Haruki Nishino

The cosmic microwave background (CMB) is remnant light from the very early universe, and CMB measurements are fundamental tools to probe the universe's origins. In particular, the detection of curl-like (odd-parity) patterns called B-modes (as opposed to even-parity E-modes) in a CMB polarization map has been one of the most important targets in experimental cosmology. Two different origins can produce such a signal on different angular scales: a primordial gravitational wave from the epoch of cosmic inflation and a weak gravitational lensing effect by the cosmological large-scale structure. In 2014, great advances were made in the field of CMB B-mode search.

Fig. 1: POLARBEAR's telescope in operation at the Atacama Desert (Chile).

In March 2014, an experiment at the South Pole, called BICEP2, claimed to detect the former, which was big news because the detection of a primordial gravitational wave may provide direct evidence for cosmic inflation. (However, the combined analysis with the Planck satellite data later showed the detected signal was greatly contaminated by galactic dust.) On the other hand, a weak gravitational lensing effect was measured by other higher-resolution experiments, including POLARBEAR, in which the Kavli IPMU has been a member of the collaboration since 2013.

POLARBEAR is a ground-based CMB polarization experiment at a 5,200 m altitude in the Atacama Desert in Chile, which is one of the most suitable environments on Earth for radio astronomy due to the dry and thin atmosphere. POLARBEAR began scientific observations in early 2012. Data from the first observation season data in 2012–2013 resulted in three peer-reviewed papers.

The first two papers (Refs. [1, 2]) describe the measurements of the gravitational lensing effects using the lensing deflection field estimated by the POLARBEAR polarization data. The estimation was performed using the correlation between different polarization modes (E-modes vs. B-modes in different angular scales) that did not initially exist at the epoch of recombination but were produced by the subsequent lensing effect. Figure 2 from the first paper (Ref. [1]) shows the auto power-spectrum of the estimated lensing field along with the prediction by standard cosmology. As expected, POLARBEAR clearly measures a non-zero lensing signal. This result provided the first evidence for a gravitational lensing effect using solely CMB polarization data. The second paper (Ref. [2]) confirms the correlation between the deflection field and the cosmic infrared background (CIB) data by the SPIRE instrument on the Herschel satellite. CIB is correlated with matter distribution around the redshift of z = 1–3, which should cause the lensing effect on CMB. If the deflection field measured by POLARBEAR is really produced by gravitational lensing, then it should correlate with the CIB signal, as demonstrated in the second paper.

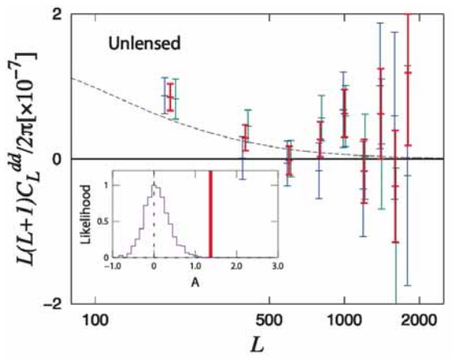

Fig. 2: Power spectrum of the gravitational lensing deflection field estimated by POLARBEAR (Ref. [1]). Red data points are combined data from the multiple modes of POLARBEAR.

The third paper in 2014 (Ref. [3]), which discusses the first direct measurement of the CMB B-mode power spectrum, became public about a week before BICEP2's first announcement. POLARBEAR's result is complementary with BICEP2's result because the angular scales are different. POLARBEAR measures the sub-degree-scale B-mode from the gravitational lensing, while BICEP2 measures the degree-scale one from the primordial gravitational wave. POLARBEAR's measurement supports the B-mode hypothesis at the 97.2% confidence level. At the time of publication, POLARBEAR's measurement was the best for the B-mode on the sub-degree angular scale.

After observing these promising signals, we are planning to upgrade our instruments to improve the precision. The upgrade project is called POLARBEAR-2/Simons Array. With a much higher sensitivity and multiple observation bands, we should be able to collect more accurate data on the B-mode and eventually garner fundamental insight on the beginning of the universe.

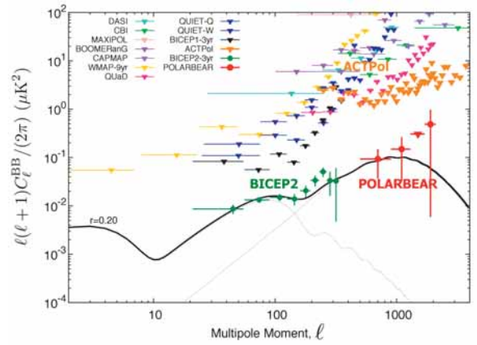

Fig. 3: Measurement of B-mode power spectra from POLARBEAR (red) and BICEP2 (green) with the results from past experiments. (Figure courtesy of Y. Chinone (UC Berkeley))

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5.10 The First Galaxy Maps from the SDSS-IV MaNGA Survey

Kevin Bundy

In astronomical observations, spectroscopy (the study of light intensity as a function of wavelength) is incredibly powerful because it tells us about the elemental composition and dynamical motion of the sources being studied. Spectroscopic surveys of galaxies thus give us clues about how their stars formed, how enriched is their gas, whether new star formation is occurring, and how the stars and gas orbit in the galaxy. It can also help reveal the presence of accreting super-massive black holes and the energy output that these black holes produce. Access to this wealth of information has motivated enormous spectroscopic campaigns such as the Sloan Digital Sky Survey-I/II, which took spectra of over 1 million nearby galaxies.

Unfortunately, previous spectroscopic surveys, while providing powerful new insight about how galaxies form and evolve, have been limited in a fundamental way: they have only obtained a single spectroscopic measurement per galaxy. As a result, astronomers have lacked information about the internal structure of galaxies. This has severely limited our ability to model growth and assembly (which occurs at different rates depending on location in a galaxy), to characterize different galaxy components (e.g., disks, bulges, bars, spiral arms), and to constrain important physical processes whose impact changes with position. Until recently, the number of nearby galaxies with spatially *resolved* spectroscopic measurements (so called, "integral field spectroscopy") was only 200-300, far too small to fully sample the rich demographics of the galaxy population.

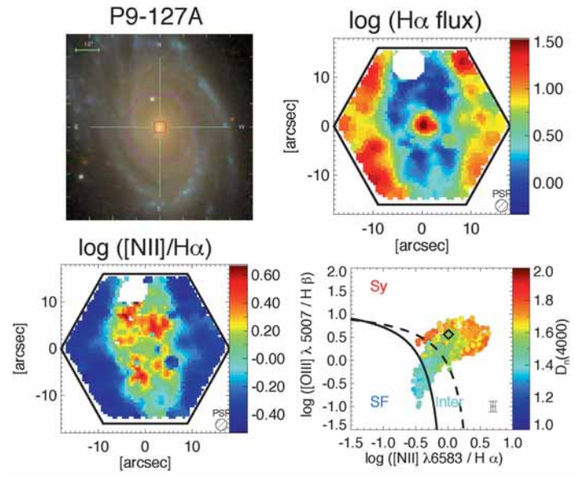
Kavli-IPMU is at the forefront of a revolution in this field thanks to a new survey called MaNGA under the leadership of Asst. Professor, Kevin Bundy. MaNGA, which stands for Mapping Nearby Galaxies at Apache Point Observatory, began in July 2014 as part of the next-generation Sloan Digital Sky Survey-IV (SDSS-IV). MaNGA is obtaining integral field spectroscopy for an unprecedented sample of 10,000 nearby galaxies (1369 unique galaxies observed as of June 2015). MaNGA's key goals are to understand the "life history" of present-day galaxies from imprinted clues of their birth and assembly, through their ongoing growth via star formation and merging, to their death from quenching at late times.

To achieve these goals, MaNGA deploys 17 arrays of optical fibers tightly packed into hexagonal bundles with a range of sizes. Over more than 500 nights spanning 6 years of operations, MaNGA observes its galaxy sample with roughly 3-hour integrations, generating 3D "data cubes" with the full optical spectrum registered at every spatial location across every galaxy. A team of over 300 scientists spread around the world is actively working on a variety of analyses with the data.

The accompanying figure shows an illustration of some of the first MaNGA data cubes and early results published in Belfiore et al. 2015. The top-left panel shows a color image from the original SDSS imaging survey of a MaNGA target. The hexagon (purple) indicates the size of the MaNGA fiber bundle placed on this galaxy. The upper-right plot maps the flux of ionized hydrogen gas as derived from the MaNGA data. The centrally-peaked emission reveals a compact nuclear star-burst surrounded by a region void of gas (perhaps excavated by winds generated by the star-burst). Greater levels of gas emission, likely accompanied by star formation, are seen in the outskirts of the MaNGA bundle.

The lower two panels in the figure are generated by using the MaNGA data to compare the strength of emission lines from different ionized elements in the associated gas. Such ratios are sensitive to the strength and sources of ionizing radiation, helping us to distinguish between the presence of hot, young stars and, for example, gas shocks due to turbulent motions. The lower-left panel maps the ratio of emission lines from nitrogen and hydrogen. Values above 0.2 are likely not from star formation, indicating that the gas-deficit region may be rife with low density shocked gas. The lower-right panel plots two line ratios against one another at every spatial location in this galaxy. Points falling to the upper right are consistent with shocks and other strong ionization sources, while those falling down and to the left are consistent with young stars. The color indicates the age of the associated stars, with blue for young stars and red for old. We see that areas with moderate ionization are indeed populated by young stars, but stronger ionization regions contain a mix of moderate-age and old stars. Has the disturbed low-density gas surrounding the nucleus somehow shut down star formation there?

The ability to reveal this wealth of information and pose such questions with a statistically powerful sample is what makes the MaNGA survey truly transformational.



References
[1] MaNGA Overview: Bundy et al. 2015, ApJ, 798, 7
[2] Belfiore et al. 2015, MNRAS, 449, 867

5.11 Detection of the Possible Companion Star of Supernova 2011dh

Gaston Folatelli & Melina Bersten

A team of researchers led by Gaston Folatelli at the Kavli Institute for the Physics and Mathematics of the Universe (IPMU) has found evidence of a hot source that could be the companion of the exploding star that gave rise to the Type IIb supernova (SN) 2011dh. The existence of the companion star had been predicted in a previous work led by Melina Bersten, also from the Kavli IPMU. The discovery provides further evidence to the interacting binary origin of this intriguing supernova that was proposed by the team. The results shed light on the long-standing question of the processes that bring massive stars to their final demise as supernovae.

SN 2011dh appeared in the nearby Whirlpool galaxy, also known to astronomers as Messier 51. It was one of the brightest supernovae of 2011 and it was also caught just a few days after explosion. These facts called the attention of researchers around the globe. Two teams of astronomers set out to search for a possible "progenitor" star in deep Hubble Space Telescope (HST) images of the supernova site obtained several years before the explosion. To their surprise, they found what seemed to be a yellow supergiant star coincident with the supernova location. According to standard theory of isolated stars, such a type of star was not supposed to undergo a supernova explosion. Moreover, based on early optical emission and radio observations of SN 2011dh, some authors claimed that the actual progenitor must have been an unseen compact object.

Soon after, however, the Kavli IPMU team, under the lead of Bersten presented evidence that the exploding star must have been extended, such as a yellow supergiant, and ruled out any compact progenitor. The question was then how a star could produce a supernova explosion while having such a structure. The same team proposed an answer: the unexpected properties of the progenitor were due to the fact that it belonged to an interacting binary system. The star exploded after transferring large amounts of mass to a companion star in a close orbit. Their model naturally explained the properties of the progenitor and of the supernova itself. Not long after the team published their work other astronomers used the HST to observe the supernova site and found that the yellow supergiant star had vanished. This confirmed the conclusion that an extended object, and not a compact star, had exploded.

Now, the interacting binary picture had yet one more prediction: the companion star must have been left at the explosion site. The team's calculations predicted that the companion was a massive, hot star emitting mostly in the blue and ultraviolet (UV) part of the spectrum. Final confirmation of the team's theories would thus have to come from the detection of such a star. It only remained to wait for the supernova to fade down sufficiently to reveal the remnant companion. This time led by observational expert Folatelli, the team requested observing time with HST to obtain deep ultraviolet imaging in order to search for the companion star. The proposal was successful and images were obtained using two UV filters in August 2014.

The new UV images confirmed the presence of a point source at the supernova site (see figure 1). After analyzing the data, Folatelli and his collaborators found that the object had a blue color, closely matching the model predictions (see figure 2). They considered the possibility that the detected flux was not due to the predicted companion but instead to a contaminant source of three possible origins. One was emission caused by the interaction of the supernova ejected material blasting on a relatively dense surrounding medium. Another source could have been a reflection of the supernova emission on nearby dust sheets, a so-called light echo. Lastly, the team considered the possibility of a chance coincidence of bright blue star in the line of sight. While none of those alternatives could be fully ruled out, the researchers judged them unlikely based on the gathered observations. Furthermore, the close resemblance with the models provided support to the interpretation as the companion star.

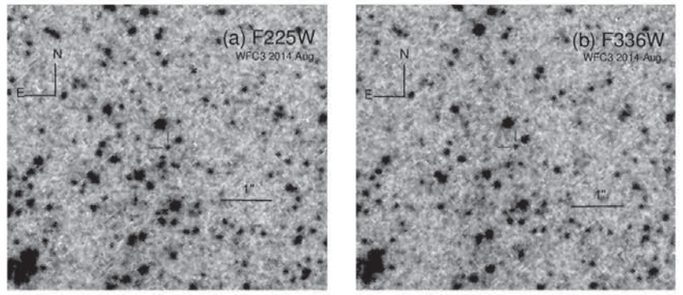


Figure 1: Deep ultraviolet images obtained with the Hubble Space Telescope (HST) by the Kavli IPMU team on August 2014. The images were obtained through two different filters and both confirm the detection of a point source at the location of SN 2011dh, as indicated in the center of the images. Photometry of the source was used to obtained colors and brightness that were compared with the binary model predictions for the companion star (see Figure 2).

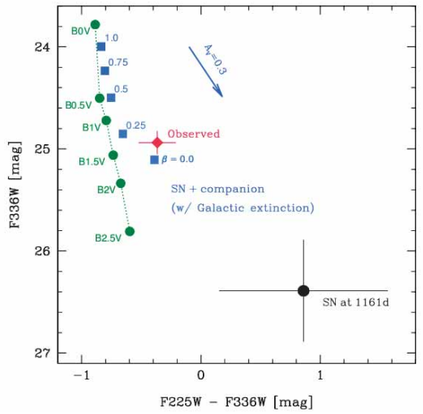


Figure 2: Ultraviolet color-magnitude diagram of the detected source (red dot) compared with predictions of the binary evolution model for different values of the mass-accretion efficiency, beta (blue squares). The location of the SN itself was estimated through extrapolation of the light curves to be at the black dot. The green circles indicate the locus of the zero-age main sequence for early B-type stars. The arrow indicates the displacement of the model predictions within the uncertainty in the interstellar extinction. The observations match the model predictions for low values of the accretion efficiency.

This finding not only supports the binary scenario for SN 2011dh, it also provides critical information to improve the theory of interacting binaries. The detection is the second claim of a companion star after that of Type IIb supernova 1993J, although in this second case with a more clear-cut detection. There is evidence that the majority of massive stars that will eventually produce supernovae belong to interacting binaries. Interest in finding companions of supernovae is rapidly increasing, although the search is difficult. The study of objects like SN 2011dh and its progenitor system can provide crucial information about the expected properties of the companion stars. In a series of articles on this SN, the Kavli IPMU team has shown the advantages of the active interplay between theory and observation to tackle this intricate matters.

5.12 Using Galaxies to Shed Light on the Dark Universe

Surhud More

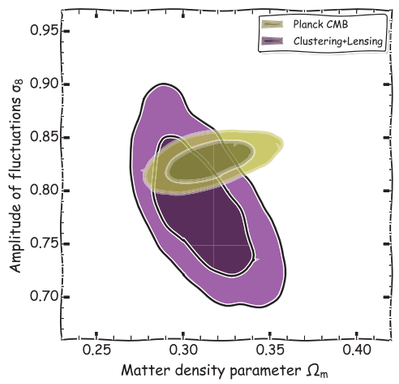
According to the concordance cosmological model, dark energy and cold dark matter dominate the energy density budget of the Universe. Dark energy governs the accelerated expansion and determines the eventual fate of the Universe. Dark matter, plays a central role in its past; it amplifies the tiny initial fluctuations imprinted in the density field in the very early Universe and results in the formation of large scale structure. The statistics of the dark matter distribution on the largest scales is governed by a number of important cosmological parameters, such as the amount of matter in the Universe (Ω_m) and the amplitude of initial density fluctuations (σ_8). Mapping out the growth of these fluctuations with time is important to understand the temporal behaviour of dark matter and dark energy.

What does the structure in the dark matter distribution look like? Dark matter particles clump together to form gravitationally bound objects called dark matter halos. As halos form at the peaks of the density field, their distribution is biased with respect to the underlying matter distribution. Galaxies form within these halos and inherit the bias of their parent halos. The relation between the mass of halos and their bias is sensitive to the cosmological parameters. In this research work, we exploited this sensitivity to obtain cosmological constraints.

The Baryon Oscillation Spectroscopic Survey of the Sloan Digital Sky Survey (SDSS-III BOSS) has obtained accurate three-dimensional positions of about a million massive galaxies spread over ~ 10000 sq. deg. of the sky as part of their observational campaign. We used these galaxies as proxies for the locations of the dark matter halos they reside in, and measured the clustering amplitude of these halos. To obtain the masses of the halos, we utilized the weak gravitational lensing effect, which is the result of bending of light due to gravity of the intervening mass, in our case, that of the dark matter halos of the BOSS galaxies. Weak gravitational lensing results in the tangential distortion of background galaxy images, but requires a high quality imaging survey with unprecedented depth for detection. For this purpose, we utilized imaging data from the Canada France Hawaii Telescope Lensing Survey, which overlapped with ~ 100 sq. deg. of data from BOSS. These data allowed us to measure the masses of the halos of our galaxies which subsequently led the inference of the cosmological parameters, Ω_m and σ_8. The consistency and complementarity of our results and those obtained by the cosmic microwave background experiment Planck is remarkable, the former based on non-linear gravitational physics in the late Universe, while the latter based on linear physics in the very young Universe. This is the first time that a technique combining the clustering and weak gravitational lensing of galaxies was used to constrain cosmological parameters at redshifts as large as z ~ 0.53.

This study is a precursor to the science that will be enabled with a much larger precision with data from the ongoing Hyper Suprime-Cam (HSC) Survey on the Subaru telescope in Mauna Kea, Hawaii. The aim of the HSC survey is to provide exquisite imaging at unprecedented depths over 1400 sq. deg. of the sky, all of it overlapping with the existing data from SDSS-III BOSS. Such data will enable joint analyses of clustering and weak lensing of galaxies, like the one presented in this article, at different epochs, tracing the growth of structure in the Universe. This is extremely important to shed light on the nature of dark energy, one of the principal goals of the survey.

These data allowed us to measure the masses of the halos of our galaxies which subsequently led the inference of the cosmological parameters, Ωm and σ8 (see purple contours in the adjacent figure).



Cosmological constraints on the matter density parameter and the amplitude of density fluctuations obtained from an analysis of the clustering of SDSS-III galaxies and their weak lensing signal. The yellow contours are from the analysis of CMB by observations using the Planck satellite.

5.13 Decoding the Gravitational Evolution of Dark Matter Halos

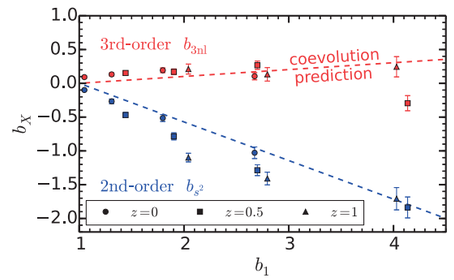
Shun Saito

In the standard scenario for the cosmic structure formation, dark matter, which has an energy budget in the universe that is approximately five times greater than ordinary matter (e.g., atoms), first gathers gravitationally to form a crowded region, the so-called dark matter halos. Then these dark matter halos attract atomic gas and eventually form stars and galaxies. Hence, to extract cosmological information from a three-dimensional galaxy map observed in gigantic galaxy surveys such as Baryon Oscillation Spectroscopic Survey (BOSS) in Sloan Digital Sky Survey III (SDSS-III, 2009-2014) and Subaru Measurement of Images and Redshifts (SuMIRe) Project (2014-), it is important to understand how clustering of dark matter halos has gravitationally evolved throughout cosmic history. This problem is referred to as the halo bias.

The halo bias is well understood at the linear level which is valid only at very large scales. On the other hand, various studies have tried to theoretically describe the nonlinear halo bias. However, none of them successfully reproduce the distribution of simulated dark matter halos. In particular, it has not been clear how to formulate the nonlinear halo bias in a physically consistent way.

In this work, we extend previous studies which formulates the nonlinear halo bias on the basis of a mathematical symmetry argument and show that the formulation indeed works well to explain the halo distribution in N-body simulations. In particular, we demonstrate that higher-order nonlocal terms originating from environmental effects such as gravitational tidal force must be taken into account to explain the nonlinear halo bias in simulations. The Figure illustrates evidence (i.e., non-zero values) of the 2nd (blue points) and the 3rd-order (red points) non-local bias terms. We also confirm that the size of such terms agrees well with a simple theoretical prediction (dashed lines), indicating that the measured values of the nonlocal terms are physically expected.

Our results demonstrate that the distribution of dark matter halos can be more accurately predicted by properly taking into account higher-order terms missed in the literature. Our refined model has been already applied to actual data analysis in the BOSS project, and will be useful for future galaxy surveys including the SuMIRe project. This study certainly improves the measurement of the nature of dark energy or neutrino masses. Hence, we believe our study contributes to a better understanding of the fundamental physics of the universe.



References

[1] S. Saito *et al.*, Phys. Rev. D 90, 123522 (2014).
[2] IPMU Press Release, "Decoding the Gravitational Evolution of Dark Matter Halos", http://www.ipmu.jp/node/2085

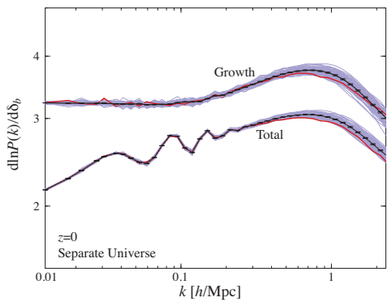
5.14 Super Sample Covariance in Simulations

Masahiro Takada

The statistical properties of large-scale structure in the universe provide a wealth of cosmological inflation on fundamental physics, including cosmic acceleration, neutrino masses, and inflation. The current standard paradigm of structure formation is the inflation-motivated, Λ and cold dark matter dominated model (ΛCDM). This model predicts that the present-day hierarchical structures such as galaxies, galaxy clusters and large-scale structure arise from gravitational amplification of the primordial seed fluctuations. Here the seed primordial fluctuations are thought to arise from inflation; the primordial fluctuations over all the scales, ranging from solar system out to the horizon scales, are generated from quantum mechanical fluctuations of the inflation field by the accelerated cosmic expansion at the beginning epoch of the universe.

However, the present-day structures on small scales, smaller than about 10 Mpc, are in the nonlinear regime, meaning that the amplitude of such small-scale fluctuations is greater than the order of unity, or greater than the mean field. Hence, the robust, linear perturbation theory is no longer valid to describe the evolution and properties of small-scale structures. To tackle this problem, N-body computer simulations are now a powerful, necessary tool to model nonlinear structure formation. However, even such an N-body simulation has a limitation: it has to employ a *finite*-size volume to model the fluctuations/spatial inhomogeneties in large-scale structure by the distribution of N-body particles. That is, it ignores the presence of fluctuations beyond the simulation box scale, the so-called super-box mode, which should exist in a real universe as predicted by an inflationary scenario. It has been thought for a long time that such a super-box mode is tiny in the amplitude, and has negligible impact on the nonlinear structure formation at small scales (sub-box modes), without any rigorous proof. However, exactly speaking, the nonlinear nature of gravity predicts that all the fluctuations of different length scales should be coupled to each other to form cosmic hierarchical structures. Exactly for the same reason, any galaxy survey has to be done in a finite volume: our cosmological observables can be affected by super-survey modes.

Based on the above background, we developed a simple, unified approach to describing effects of the super-box mode on large-scale structure in an N-body simulation. We showed that the super-box mode, the part of homogenous, coherent density fluctuation mode across the N-body box, can be absorbed into changes in cosmological parameters – the so-called separate universe approach. In simpler words, if a finite-volume region is embedded into a coherently overdense region, the region will be effectively viewed as a slightly positive curvature universe, even if the true universe has a flat geometry. In such an overdense region structure grows more quickly and the region expands less quickly. Thus the super-box mode affects all the small-scale structures. In a series of our papers (Li, Hu & Takada, 2014, PRD, 89, 083519; 2014, PRD, 90, 103530) we demonstrated that this separate universe technique is so powerful and useful to include and calibrate the effects of super-box/survey modes on structure formation. Because such large-scale modes contain cleaner information on the physics of inflation, our results open up a new window to extract the information on fundamental physics from large-scale structure observables. Several other groups are now following our study.



The response of the matter power spectrum to the coherent super-box mode, δ_b, calibrated using the separate universe technique of N-body simulations (Li, Wayne & Takada, 2014, PRD, 89, 083519). The super-box modes cause two effects: the presence of super-box mode causes a change in the amplitude of growth of structure – the growth effect, and the other is from a change on the scale or features in the power spectrum – the dilation effect. The two curves show the growth effect in the response, and the total response, respectively.

6 AWARDS

Toshiyuki Kobayashi: Medal with Purple Ribbon

On April 28, 2014, the Japanese government announced this spring's recipients of the Medal of Honor. Toshiyuki Kobayashi, Professor at the Graduate School of Mathematical Sciences, the University of Tokyo, and Principal Investigator at the Kavli IPMU, was selected as a recipient of the Medal with Purple Ribbon in the field of mathematics. The Medal with Purple Ribbon is awarded to people who have made outstanding contributions in academic fields, the arts, and sports.

Professor Kobayashi's research is magnificent in scope, ranging from algebra to geometry and analysis, with a key word of "symmetry," and his achievements are influential in the whole area of mathematics. In particular, the following achievements received high recognition internationally and realized essential breakthroughs in mathematics: (1) Pioneering the theory of "discontinuous groups for homogeneous spaces beyond Riemannian geometry"; (2) Substantial breakthrough in the theory of "branching laws of infinite-dimensional representations," particularly, creating the theory of "discretely decomposable restrictions"; (3) Pioneering work on the "global analysis arising from minimal representations"; (4) Original theory of "visible action on complex manifolds" towards a unified theory of multiplicity-free representations.

JMSJ Outstanding Paper Prize

Toshiyuki Kobayashi, Professor of the Graduate School of Mathematical Sciences, the University of Tokyo, and Principal Investigator of the Kavli IPMU received the 2015 JMSJ Outstanding Paper Prize. This prize is awarded to the authors of up to three outstanding articles published in the Journal of the Mathematical Society of Japan (JMSJ) in the previous year. Professor Kobayashi and his coauthors, J. Hilgert and J. Möllers, received this honor for their paper, "Minimal representations via Bessel operators," which was published in JMSJ 66 (2014) 349-414.

Yuji Tachikawa: Hermann Weyl Prize

Yuji Tachikawa, Associate Professor at the School of Science, the University of Tokyo, and a Scientist at the Kavli IPMU has won the Hermann Weyl Prize 2014 for his outstanding contributions to the understanding of supersymmetric quantum field theories; in particular, the discovery of the Alday-Gaiotto-Tachikawa correspondence that has led to spectacular advances in both mathematics and quantum physics. He is the first Japanese awardee of the Hermann Weyl Prize, which was established in 2000 for the purpose of providing recognition for young scientists who have performed original, significant work in furthering the understanding of physics through symmetries. The candidate should either be under thirty-five years of age, or within five years of having received the doctoral degree.

Nishinomiya-Yukawa Memorial Prize

Yuji Tachikawa, Associate Professor at the School of Science, the University of Tokyo and a Scientist at the Kavli IPMU, has won the 29th Nishinomiya-Yukawa Memorial Prize for "the discovery of the correspondence relation between quantum field theories in different dimensions."

Hirosi Ooguri : Kodansha Science Book Prize

Hirosi Ooguri, Principal Investigator of the Kavli IPMU (He is also Fred Kavli Professor of Theoretical Physics and Mathematics at the California Institute of Technology (Caltech) as well as the Founding Director of the Caltech's Burke Institute) has won the 30th Kodansha Prize for Science Books for publishing a Japanese popular science book on superstring theory *(大栗先生の超弦理論入門 九次元世界にあった究極の理論—Professor Ooguri's Introductory Lecture: Ultimate Theory Is Found in the Nine Dimensional World, Kodansha Blue Backs, 2013).*

Katsuhiko Sato: Person of Cultural Merit

President of the National Institutes of Natural Sciences and Visiting Senior Scientist of the Kavli IPMU, Katsuhiko Sato, who had served as a Principal Investigator at the IPMU from its launch to the end of March, 2010, has been selected as a Person of Cultural Merit (Bunkakorosha) in 2014 for his outstanding contributions to astrophysics and cosmology research, and for promotion of science.

Tsuyoshi Nakaya: Nishina Memorial Prize

Tsuyoshi Nakaya, Professor at the Graduate School of Science, Kyoto University and a Kavli IPMU Visiting Senior Scientist, has been awarded the 2014 Nishina Memorial Prize, together with Takashi Kobayashi, a Professor at KEK, for "the discovery of electron neutrino appearance in a muon neutrino beam," in the T2K long-baseline neutrino experiment.

Yukinobu Toda: JSPS Prize

Yukinobu Toda, Associate Professor at the Kavli IPMU, has won the 11th JSPS (Japan Society for the Promotion of Science) Prize for his work on "the derived category of coherent sheaves and curve counting invariants."

Tadashi Takayanagi: New Horizons in Physics Prize

Tadashi Takayanagi, Professor at the Yukawa Institute for Theoretical Physics, Kyoto University, and Visiting Senior Scientist at the Kavli IPMU, has been awarded the 2015 New Horizons in Physics Prize, together with Ryu Shinsei, Associate Professor at the University of Illinois at Urbana-Champaign, for "fundamental ideas about entropy in quantum field theory and quantum gravity."

Robert Quimby: Breakthrough Prize in Fundamental Physics

The Fundamental Physics Prize Foundation has announced that the recipients of the 2015 Breakthrough Prize in Fundamental Physics are: Saul Perlmutter and members of the Supernova Cosmology Project; Brian P. Schmidt, Adam Riess, and members of the High-Z Supernova Team. Their discovery of the accelerating expansion of the universe is recognized. Robert Quimby, now Associate Professor at San Diego State University, Director of Mount Lagna Observatory, and Visiting Scientist at the Kavli IPMU, is among the recipients, as he is a member the Supernova Cosmology Project.

Roger Wendell: PSJ Young Scientist Award

Roger Wendell, Assistant Professor at the Institute for Cosmic Ray Research, the University of Tokyo and Associate Scientist at the Kavli IPMU, has won the 2015 Young Scientist Award of the Physical Society of Japan for his outstanding contributions to "Evidence for the Appearance of Atmospheric Tau Neutrinos in Super-Kamiokande," a paper published by the Super-Kamiokande Collaboration in Phyical Review Letters 110 (2013) 181802.

Eiichiro Komatsu: Chushiro Hayashi Prize

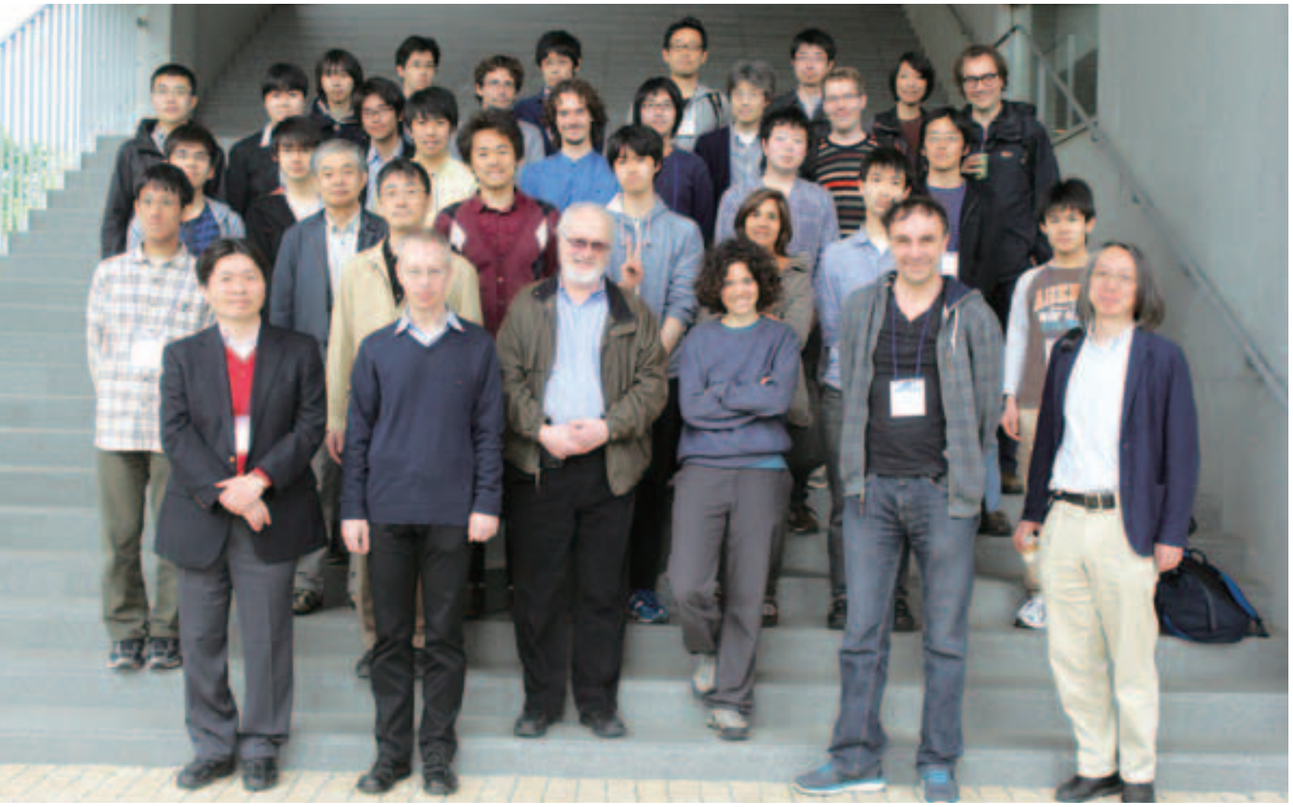
Eiichiro Komatsu, Director of the Max Planck Institute for Astrophysics and Visiting Senior Scientist of the Kavli IPMU, received the 2014 Chushiro Hayashi Prize for "Precision Cosmology Based on the Cosmic Microwave Background (CMB)." From 2001 to 2010, he worked as a key member of the WMAP team, leading data analysis and theoretical interpretation. He is the first author in some frequently-cited WMAP papers. For these reasons, his contribution to the development of astrophysics has been recognized.

Tsuyoshi Nakaya & Masato Shiozawa: Yoji Totsuka Memorial Prize

Tsuyoshi Nakaya, Professor of Kyoto University and Visiting Senior Scientist of the Kavli IPMU, and Masato Shiozawa, Professor of the Institute for Cosmic Ray Research, the University of Tokyo and Senior Scientist of the Kavli IPMU shared the 6th Yoji Totsuka Prize with Takashi Kobayashi, Professor of the Institute of Particle and Nuclear Studies, High Energy Accelerator Research Organization (KEK) for "the observation of electron neutrino appearance in a muon neutrino beam" in the T2K long-baseline neutrino oscillation experiment.

7 CONFERENCES

7.1 Workshop on "Floer and Novikov Homology, Contact Topology and Related Topics"



Andrei V. Pajitnov
Professor at the Department of Mathematics, the University of Nantes and Kavli IPMU Senior Visiting Scientist

This International Workshop was held at the Kavli IPMU from April 21 to April 24, 2014. The aim of the meeting was to bring together the experts from different domains of geometry and topology related to the Floer and Novikov homology and the contact topology. There were 13 speakers and about 50 participants in total.

An application of the classical algebro-topological tools to the contact topology (namely to the growth of the number of Reeb chords in the cotangent bundles) was the subject of the talk by Urs Frauenfelder (joint with F. Schlenk), which opened the Workshop.

The Floer theory was the subject of the talk of Mihai Damian, who spoke about lifted Floer cohomology, which is a variant of Lagrangian Floer cohomology and its application to topology of monotone Lagrangian submanifolds. His methods allow in particular to show that nontrivial connected sums of manifolds of odd dimensions do not admit monotone embeddings to the complex affine space.

Kei Irie gave an estimate of Hofer-Zehnder capacity using symplectic homology, product structures, and Chas-Sullivan loop product.

A generalization of the Morse-Novikov theory to the case of ANR spaces and continuous maps was discussed in the talk of Dan Burghelea. He suggested new topological invariants related to such maps, and computer-friendly tools to calculate these invariants. F. Manjarrez-Gutierrez spoke about the Morse-Novikov number for a-small knots. A conjecture, due to M. Boileau and C. Weber, says that the Morse-Novikov number for knots is additive, similarly to the knot genus. F. Manjarrez-Gutierrez confirmed this conjecture for the class of a-small knots.

Classical Morse theory was discussed in the talk of Manabu Akaho, who presented his construction of a Morse complex for Morse functions on manifolds with boundary. Tadayuki Watanabe spoke about relations of the Morse theory to Chern-Simons perturbation theory.

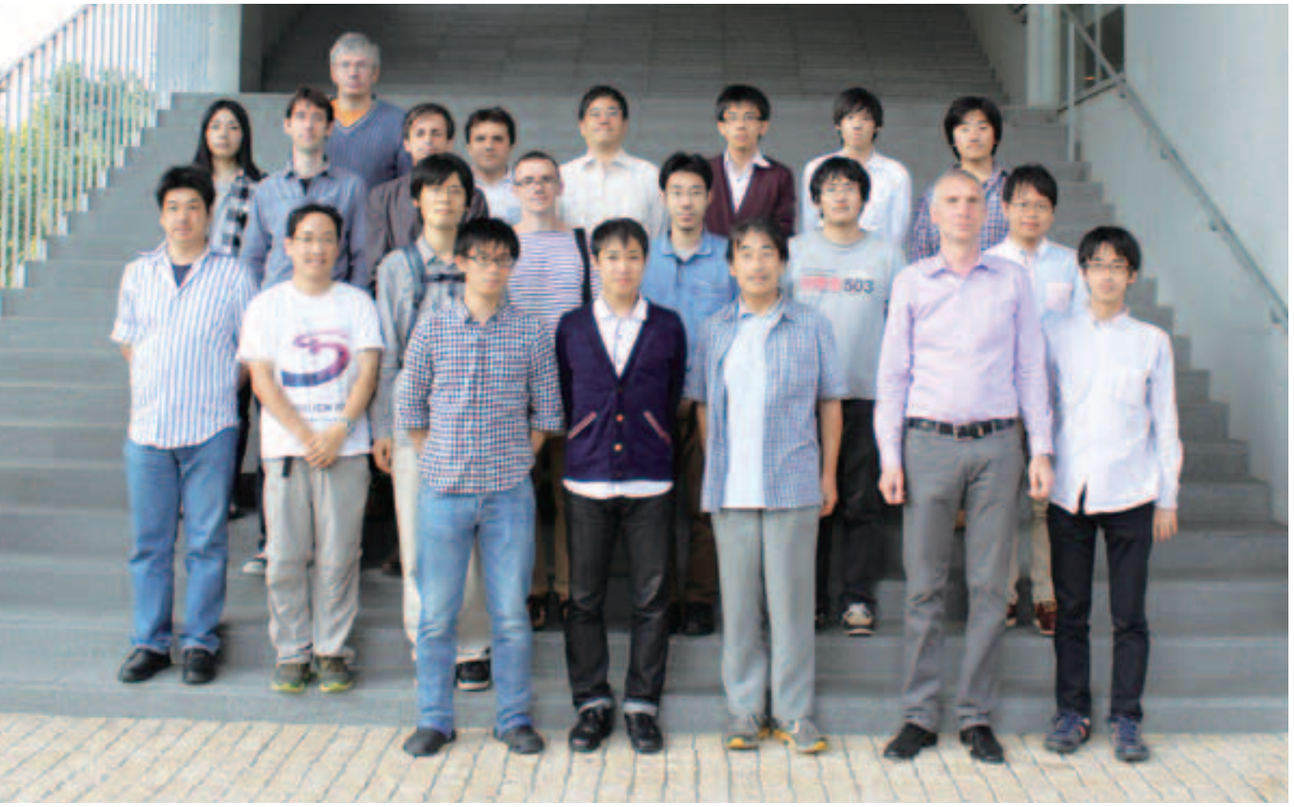
The talk of Yasha Saveliev was dedicated to the global Fukaya category and its applications to Hofer geometry. Several talks were dedicated to the contact topology. River Chiang presented some examples of higher dimensional non-fillable contact manifolds. Tetsuya Ito's lecture was about open book foliations. Otto van Koert spoke about fractional twists in contact topology.

S. Sandon spoke about the positive loops of contactomorphisms. She explained how non-squeezing property for contact manifolds holds or fails, and how the group of contactomorphisms admits or does not admit orderablity.

The conclusive talk of the Workshop was delivered by Vincent Colin. His joint work in progress with Ko Honda is related to both the contact topology and the Floer homology. He presented a construction of a hat version of Heegaard Floer homology for contact manifolds of arbitrary odd dimension.

The Workshop was a highly successful event that enabled experts in symplectic and contact topology from all over the world to present their results and communicate with each other.

7.2 Mini-Workshop: Towards Quantum Primitive Form Theory



Kyoji Saito
Kavli IPMU Principal Investigator

As a joint program of the Kavli IPMU and the FMSP Program, a mini-workshop, "Towards Quantum Primitive Form Theory," was held on October 8-10, 2014 at the Kavli IPMU (organizers: Toshitake Kohno and Kyoji Saito). The aim was to cover some recent developments related to period maps for primitive forms, which may lead to understanding of the quantization of primitive forms. The schedule and the contents of the talks are as follows.

Oct.	10:00-11:30	13:30-15:00	15:30-17:00
8	Kapranov1	Iwaki1	Ikeda1
9	Ikeda2	Kapranov2	Iwaki2
10	Iwaki3	Ikeda3	Kapranov3

Akishi Ikeda (Graduate School of Mathematical Sciences, Univ. of Tokyo):
Stability conditions on *N*-Calabi-Yau categories associated to A_n-quivers and period maps
Recently, Bridgeland and Smith constructed stability conditions on some 3-Calabi-Yau categories from meromorphic quadratic differentials with simple zeros. In this talk, generalizing their results to higher dimensional Calabi-Yau categories, he described the space of stability conditions on N-Calabi-Yau categories associated to A_n-quivers as the universal cover of the compliment of the discriminant-loci of the universal deformation space of the simple singularity of type A_n. In particular, central charges of stability conditions on N-Calabi-Yau categories are constructed as the periods of quadratic differentials.

Kohei Iwaki (RIMS, Kyoto Univ.):
Theory of exact WKB analysis and relation to cluster algebras
Exact WKB analysis is an effective method for the global study of differential equations (containing a large parameter) defined on a complex domain. On the other hand, a cluster algebra is a particular class of commutative subalgebra of a field of rational functions with distinguished generators. He first gave an exposition of the theory of exact WKB analysis. In the third lecture he explained the main result on a hidden cluster algebra defined by a quiver associated with the Stokes graph in exact WKB analysis (a joint work with T. Nakanishi). The Voros symbols realize the cluster variables, which are generators of the cluster algebra.

Mikhail Kapranov (Kavli IPMU, Univ. of Tokyo):
Secondary polytopes and Landau-Ginzburg models
The secondary polytope of a point configuration A was originally introduced to describe the Newton polytope of a multivariate discriminant. The point configuration appeared as the set of exponents of the monomials of a polynomial. In these talks, based on joint work with M. Kontsevich and Y. Soibelman, he discussed a new appearance of secondary polytopes, when A is the set in the complex plane formed by the critical values of a complex Morse function. To these polytopes, he associates homotopy Lie algebras, which provide algebraic framework for a deformation theory construction of Picard-Lefschetz theory as proposed by the work of Gaiotto, Moore and Witten on the "Algebra of infrared."

7.3 Workshop on CLASS and MontePython

Eiichiro Komatsu
Director, Max Planck Institute for Astrophysics / Kavli IPMU Visiting Senior Scientist

We organised a workshop on "CLASS and MontePython" (October 27-31, 2014), where participants can learn how to use the latest cosmological linear Boltzmann code "CLASS" and the Markov Chain Monte Carlo wrapper "MontePython," via lecturers and intensive hands-on exercises. The lecturers were the authors of the codes: Drs. Julien Lesgourgues, Benjamin Audren, and Thomas Tram. The linear Boltzmann code and the Markov Chain Monte Carlo code are indispensable tools in the research of modern cosmology, as the former is necessary to make theoretical predictions, and the latter is to compare the predictions with the data. However, developing these tools from scratch is redundant, and simply downloading and understanding the existing codes written by someone else is painful and takes an enormous amount of effort. This is why we invited the authors of the latest, user-friendly codes such as CLASS and MontePython, in order to provide students and junior researchers with one-and-only opportunities to master these codes. We had 42 participants from institutions all over Japan. The participants were enthusiastic and eager to learn, asking many questions and working hard on the exercises provided by the lecturers. While the original program for each day was supposed to end at 16:30, many participants stayed in the lecture hall until they were kicked out at 18:00. We would like to thank the participants for their enthusiasm, as well as the lecturers for their hard work in preparing for such a wonderful program. The lecturers were completely exhausted by the end of the workshop, but they were thoroughly impressed by the enthusiasm of the participants. Overall, the workshop was a great success, making a large impact on students and junior researchers working on cosmology in Japan. However, there is one thing that we must improve: we were disappointed to see that less than 10% of the participants were female. We used mailing lists such as tennet and rironkon to advertise this workshop broadly, but somehow we failed to encourage the participation of female students and scientists. We must work to more actively encourage the participation of females. We would like to thank the Kavli IPMU and the staff for generous support, which made this workshop possible.

7.4 Kavli IPMU–RIKEN iTHES–Osaka TSRP Symposium
Frontiers of Theoretical Science–MATTER, LIFE and COSMOS–

Tsukasa Tada
Vice Chief Scientist, Riken

A symposium entitled, "Frontiers of Theoretical Science–MATTER, LIFE and COSMOS–," was held on November 6th at the lecture hall of the Kavli IPMU. It was organized jointly by the Kavli IPMU, Riken iTHES (RIKEN interdisciplinary Theoretical Science Group), and Osaka TSRP (Theoretical Science Research Project, Osaka University). Research cooperation among these three institutes is founded on two bilateral agreements between the Kavli IMPU and iTHES, and also between the Osaka TSRP and iTHES respectively. This symposium was the first significant manifestation of the cooperation among these three research institutes, which are actively pursuing theoretical study on a broad range of science.

The symposium started with introductory remarks by Tetsuo Hatsuda, Director of the RIKEN iTHES, followed by the commendation for the research cooperation among the institutes from Yasuhiro Yukimatsu, Director of Basic Research Promotion Division, Research Promotion Bureau, MEXT.

Then, Hirosi Ooguri from the Kavli IPMU and Caltech delivered the first scientific lecture, which covered various topics of string theory and its applications. Also, Hitoshi Murayama, Director of the Kavli IPMU, talked on the Nambu-Goldstone theorem and the Higgs mechanism in non-relativistic systems. The other three presentations by younger researchers, Mauricio Romo and Jonathan Malts from the Kavli IPMU, and Masakiyo Kitazawa from Osaka University, comprised the session before the lunch.

The first session in the afternoon was opened by an entertaining lecture by Franco Nori from RIKEN on quantum circuits. Yuji Sugita, also from RIKEN impressed the audience with his computer simulation of biological systems. Yoshitomo Kamiya of the RIKEN iTHES and Shinichiroh Matsuo from Osaka University also gave short presentations in this session.

After the tea break held at Piazza Fujiwara, the symposium resumed for the last session. In this session, Koichi Fujimoto from Osaka University shared his perspectives on theoretical biology. Shinya Wanajo and Koichiro Uriu from RIKEN as well as Ryo Namba from the Kavli IPMU also gave short presentations. A talk by Eiichiro Komatsu from the Max Planck Institute and the Kavli IPMU on the Early Universe and the observation of the cosmic microwave background concluded the symposium.

The symposium attracted more than a hundred keen audiences and every talk was followed by perceptive questions and lively discussions. The discussions went on over lunch, coffee break, and the banquet held at the cafeteria after the symposium. The success of the symposium yields a great deal of hope for fruitful cooperation among three institutes in future.

7.5 The 24th Workshop on General Relativity and Gravitation in Japan (JGRG24)

Tomohiro Fujita
Kavli IPMU Graduate Student

Shinji Mukohyama
Professor of the Yukawa Institute for Theoretical Physics, Kyoto University and Kavli IPMU Visiting Senior Scientist

Ryo Namba
Kavli IPMU Postdoctoral Fellow

Rio Saitou
Postdoctoral Fellow, Yukawa Institute for Theoretical Physics, Kyoto University

The 24th Workshop on General Relativity and Gravitation in Japan (JGRG24) was held at Kavli IPMU from November 10 through 14, 2014. The JGRG is a series of annual workshops that have continued since 1991 with the aim of comprehensive understanding of the General Relativity (GR) and gravity through various approaches.

The recent progress on cosmological and astrophysical observations has been outstanding. The space-based observations of the Cosmic Microwave Background (CMB) have determined cosmological parameters with unprecedented precision, and the ground-based observations of the CMB polarizations have provided various hints to the existence and nature of gravitational waves (GWs). Based on several proposed projects for direct detection of GWs, the construction of GW interferometers is already underway. Moreover, observational techniques have been progressively improved to search for the neutrinos that emerge from various astrophysical objects and to probe the detailed nature of dark energy.

On the theoretical side, there have been extensive studies on inflationary models that predict the amount of primordial GWs consistent with the observations. The models in bigravity and massive gravity theories, which have recently been developed, are only a few of the examples. Theories of various fields, such as modified gravity, string, quantum gravity, and mathematical relativity, have also been experiencing intriguing advances. For example, new scalar-tensor theories have been proposed, and the properties of black holes in different space-times and/or dimensions have been explored.

The JGRG24 hosted approximately 180 attendants from 15 different countries, with 9 invited talks, 67 contributed talks, and 38 poster presentations. The topics spanned a broad range in both observational and theoretical aspects, such as dark matter, axion cosmology, string theory, black holes, modified gravity, GW experiments, stellar formations, CMB, large-scale structure, topological defects, inflation, gravitational lensing, and neutrinos. Each subject received intensive discussions with enthusiasm. A few young researchers and students were selected and received awards for their outstanding presentations at the end of the workshop.

7.6 Galaxies and Cosmology in Light of Strong Lensing

Masamune Oguri
Assistant Professor of Graduate School of Science, the University of Tokyo
and Kavli IPMU Associate Scientist

Gravitational lensing continues to grow in importance as a tool to explore the Universe which is dominated by dark components. In particular, strong gravitational lensing plays an important role in studying small-scale structure of dark matter distributions, distant objects with help of lensing magnifications, and cosmological parameters by taking advantage of its simple physics. This is why we held the workshop, "Galaxies and Cosmology in Light of Strong Lensing," from November 17 to 21. This workshop has successfully attracted a great deal of attention, probably because workshops focusing on strong lensing have been rare. As a result, the workshop was truly international, with 70 participants, about 50 of which were from outside Japan.

In this workshop, we assigned different topics for different days. On Monday we discussed (mostly time delay) cosmology, Tuesday was devoted to dark halo substructures and fine structure of sources, Wednesday to galaxy and cluster structures, Thursday to distant galaxies, and Friday featured strong lens searches. One unique feature of this workshop was that we had an hour of open discussion time at the end of each day, in addition to many invited and contributed talks.

One of the main discussion points was the role of simulations and mock data. It was suggested that blind analysis of mock data is very useful in checking the presence of any bias in the results, and in understanding the true uncertainties of the analysis of strong lensing data that are usually limited. It was also argued, on the other hand, that very detailed analysis of strong lens systems may not be practical as it is sometimes very time-consuming. Another important point in the discussions was how to make lens searches and lens mass modeling more efficient, possibly in automated way, given the fact that ongoing and future surveys will easily find hundreds of new strong lens systems. The discussions were held in a critical but friendly atmosphere, which were so fulfilling that the discussion time passed very quickly.

This workshop would not have been possible without the help of the other organizing committee members, Eiichiro Komatsu, Anupreeta More, Surhud More, Sherry Suyu (ASIAA), and Masahiro Takada. I also thank the Kavli IPMU administrative office members, especially Shoko Ichikawa, for their dedicated support.

7.7 String Theory in Greater Tokyo

Charles Melby-Thompson
Kavli IPMU Postdoctoral Fellow
René Meyer
Kavli IPMU Postdoctoral Fellow

The Kavli IPMU greeted 2015 by hosting the inaugural workshop in a new series, String Theory in Greater Tokyo. The workshop series is aimed at bringing together researchers in string theory and related fields from throughout Tokyo and the surrounding prefectures.

Each workshop is a one-day event held at a different institution in the Tokyo area. The workshops offer several talks by well-known researchers in various fields, but also place a strong emphasis on interaction and collaboration between participants. The next workshop will be organized by the high energy physics group at RIKEN, on June 9, 2015.

The inaugural workshop took place on January 19, and was organized by the Kavli IPMU members Simeon Hellerman, Charles Melby-Thompson, René Meyer, and Masahito Yamazaki. There were roughly 50 scientists in attendance.

We were pleased to welcome as the series' first lecturers Prof. Xi Yin (Harvard University), Dr. Dionysios Anninos (Institute for Advanced Study), and Prof. Daniel Grumiller (Vienna University of Technology).

Recent developments in little string theory found a clear expositor in the first talk by Prof. Xi Yin. He discussed his recent work on scattering amplitudes in double scaled little string theory and the UV completion of 6D super Yang-Mills theory. By expressing correlators in little string theory in terms of correlation functions of exactly solvable CFTs, he could compute numerical coefficients in the α' expansion. The results shed light on the structure of the perturbation theory expansion of 6d super Yang-Mills.

The second talk by Dr. Dionysios Anninos dealt with the long-standing problem of defining a consistent quantum theory on de Sitter space-time. His approach was to constrain the theory using holography. In Vasiliev's theory of higher spin gravity he calculated the de Sitter entropy, and argued that his result implies an upper bound on the number of degrees of freedom produced during inflation, hence predicting additional correlations in the Cosmic Microwave Background. He finished with several thoughts about promising lines of attack on this long-standing problem.

Prof. Daniel Grumiller's lecture was on three-dimensional gauge-gravity duality beyond AdS/CFT. He discussed several ideas extending AdS/CFT in three dimensional toy models of gravity, including higher derivative gravity, higher spin gravity, and holography in flat space. One very interesting program regards extending the AdS/CFT correspondence to non-unitary systems. His clear exposition was of great help to those interested in pushing the envelope of the gauge-gravity correspondence.

In addition to the talks, participants also appreciated ample time for interaction with other researchers. Many introductions were made and new contacts formed, making the workshop a promising start to what we hope becomes a long tradition at the Kavli IPMU and throughout Greater Tokyo.

7.8 The 6th Open Meeting of the Hyper-Kamiokande Project

Mark Hartz
Kavli IPMU Assistant Professor

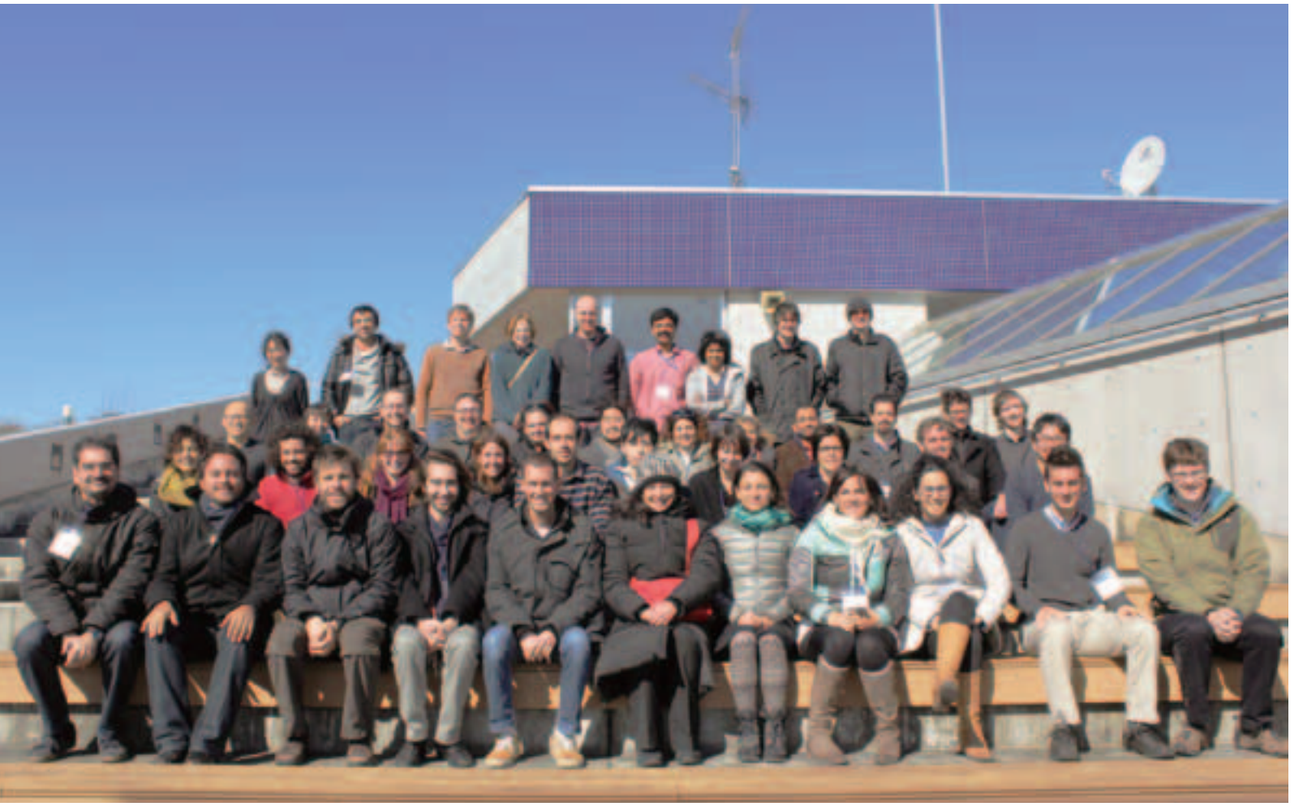
The discovery of muon neutrino to electron neutrino oscillations by T2K in 2013 has focused the attention of the experimental neutrino community on next generation neutrino experiments that will make precision searches for CP violation in the lepton sector. Hyper-Kamiokande (Hyper-K) is a proposed 1 megaton water Cherenkov detector in Japan that will have the world's best sensitivity to detect CP violation by neutrinos. Hyper-K will also make the world's best searches for nucleon decay and world leading measurements with accelerator, atmospheric, supernova, and solar neutrinos. The 6th Open Meeting of the Hyper-Kamiokande Project was held at the Kavli IPMU on January 28-31. The meeting was attended by 123 scientists from 12 countries who are collaborating to realize the successful design, construction, and operation of Hyper-K.

The meeting included sessions covering the design of the Hyper-K cavity and tank, water system, photo-detectors, electronics, calibration system, and near detectors. Sessions also covered the J-PARC accelerator status, analysis software development, and Hyper-K physics potential studies. Among the highlights was the photo-detector session, where test results from new photo-detector technologies including high quantum efficiency photocathodes, hybrid photo-detectors, and new dynode designs were presented. The goal of these studies is to identify technological solutions that can be used to maximize the physics potential of Hyper-K in a cost effective manner. The meeting included a tour of the photo-detector testing facility located in the Institute for Cosmic Ray Research (ICRR) building on the Kashiwa campus.

In addition to Hyper-K design reports, the J-PARC beam facilities that will provide the accelerator neutrinos to Hyper-K and designs for near detectors that will characterize the accelerator neutrino beam at its source were presented. The beam reports focused on the potential for delivery of a megawatt power beam to Hyper-K. The near detector reports presented novel detector designs that will make measurements to address one of the dominant sources of uncertainty for Hyper-K, the modeling of neutrino interactions with nuclei. These sessions emphasized the synergy between the neutrino beam facilities of J-PARC and the Hyper-K detector to achieve world leading measurements.

Perhaps the most exciting development from the meeting was the launch of the Hyper-K proto-collaboration. The new proto-collaboration structure will enable the Hyper-K project to successfully move from the conceptual design stage to a funded, built, and operating experiment. The proto-collaboration formation culminated with the signing of a memorandum of understanding (MOU) between the KEK Institute of Particle and Nuclear Studies (IPNS) and the University of Tokyo Institute for Cosmic Ray Research (ICRR) by IPNS director Masanori Yamauchi and ICRR director Takaaki Kajita. The signing ceremony included talks highlighting the achievements of the Japanese experimental neutrino program and emphasizing the importance of international collaboration to realize the Hyper-K experiment.

7.9 Workshop on "Getting a Grip on Galactic Girths"



Kevin Bundy
Kavli IPMU Assistant Professor

One of the most puzzling conclusions from the last decade of galaxy observations is that massive, elliptical galaxies apparently grow in size by a factor of nearly five after they form, roughly 12 billion years ago. This growth is mysterious because ellipticals otherwise seem to change very little after they are established at early times. Numerous explanations have been put forward but none is completely satisfactory, motivating further observations to quantify the exact rates of growth, which apparently depend on the cosmic epoch as well as the galaxy's mass, type, and local environment, not to mention detailed assumptions about the size measurement itself.

This active area of research was the subject of a lively Kavli IPMU Focus Week (February 2-6, 2015) titled "Getting a Grip on Galactic Girths." Organized by Kavli IPMU astro postdocs Benedetta Vulcani, Claire Lackner, and Song Huang, with support from faculty members Alexie Leauthaud and Kevin Bundy, the meeting drew a highly diverse and international audience for a week of focused talks and intense discussion. Particular attention was given to ensuring ample time for debate and to highlighting work by young researchers in the field as exemplified by the outstanding response to the final meeting summary given by postdoc Song Huang, a privilege typically reserved for the most senior attendees at academic meetings.

The meeting generated a very positive immediate response. Participants were appreciative of the opportunity to get a global view of the latest work in the field, as told by some of the most active researchers. In addition, several aspects of the subject that were initially hazy, emerged from the week with greater clarity. There was some consensus, for example, that galaxies living in dense environments (e.g., galaxy clusters) at early times have experienced accelerated size growth, a head-start that apparently disappears by the present day. There was also progress towards interpreting apparently discrepant observations about the frequency of galaxies with a certain size and mass over cosmic time.

One of the meeting highlights was the full Kavli IPMU APEC seminar given by Nacho Trujillo, one of the founders of the subject. Dr. Trujillo relayed his successful hunt for "relic" galaxies that have remained compact and unevolved since their initial formation. He argued that such a relic galaxy was present in our own backyard, cosmologically speaking, affording a valuable opportunity to study how these objects form. His observations represent just one of the many programs astronomers presented at the Focus Week that seek to resolve the physical nature of galaxy growth in the coming years.

7.10 Key Aspects in Exploring Road to Unification (KAERU Conference)

Shinya Kanemura
Associate Professor of Graduate School of Science and Engineering for Research, Toyama University

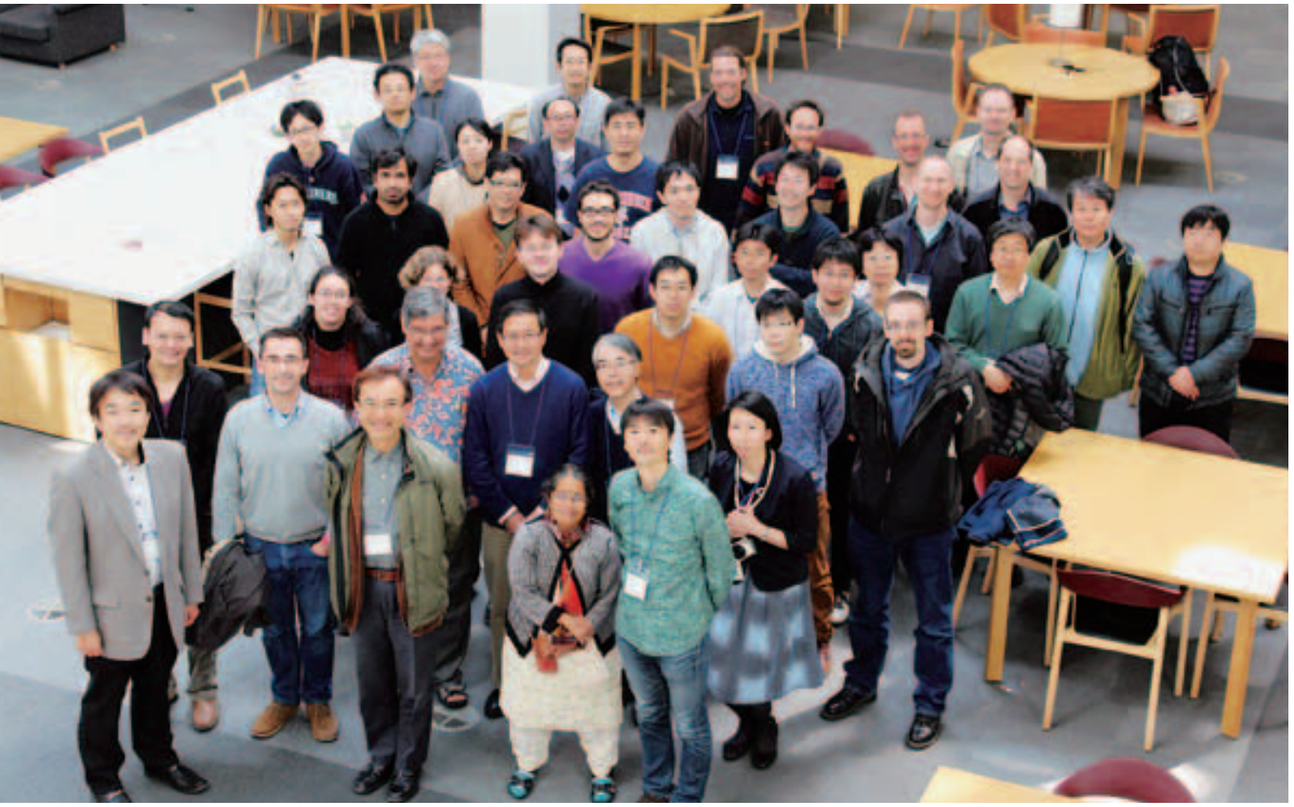
The International Conference "Key Aspects in Exploring Road to Unification (KAERU Conference)" was held at the Kavli IPMU from 25 March 2015 for two days. It was a pure scientific conference for high energy physics on the occasion of the retirement from KEK at the end of March 2015 of Kaoru Hagiwara, who has achieved great contributions to particle physics for a long time from the era of the experimental establishment of the standard model up to the present day, the era of exploring the new physics beyond the standard model. The conference was planned by a group of Kaoru's former students and collaborators such as Hitoshi Murayama, Yukinari Sumino, and Gi-Chol Cho, and was realized with the cooperation of the Kavli IPMU. Reflecting the wide research areas in high energy physics to which Kaoru has contributed and also his wide circle of friends all around the world, more than 110 researchers including about 40 from abroad participated in KAERU Conference, so that the conference was a fruitful one, covering a wide range of the fields in high energy physics.

On the first day, following the opening address by Murayama (Chair of the conference) and Sumino (Co-Chair) and greetings by Hagiwara, Roberto Peccei gave a talk on the physics of axion and its relation to cosmology. Zoltan Fodor then spoke about the recent development of lattice calculations for hadron masses. Light higgsino scenarios solving the naturalness problem have been discussed by Xerxes Tata and Howard Baer. Keisuke Fujii presented the physics at the International Linear Collider. In the afternoon, after Thomas Teubner and Naohito Saito gave talks on theoretical and experimental developments on muon g-2, recent results by Hagiwara on T-odd Asymmetry etc. were given by his collaborators Toshifumi Yamada, Hiroshi Yokoya and Kentarou Mawatari etc. Kingman Chiang then gave a talk about the model independent analyses of the Higgs boson pair production.

On the second day, Dieter Zeppenfeld discussed the QCD correction to vector boson fusion processes at hadron colliders, Manuel Drees spoke on the topic of naturalness, and Tilman Plehn stressed the importance of study of jets at LHC. Then Junichi Kanzaki, Rohini Godbole and Fabio Maltoni gave talks on LHC phenomenology. In the afternoon, Tao Han discussed the potential of a 100 TeV hadron collider, and Nobuchika Okada discussed the prospects of SUSY phenomenology. There were then several talks on neutrino physics such as T2KK, CP violation in the lepton sector, and testability of Majorana neutrinos. Finally, after Murayama discussed a new model for SUSY breaking and dark matter, Cho closed the conference.

Therefore, at the conference, a variety of interesting topics in particle phenomenology were discussed, in particular, in collider physics, QCD physics, models beyond the standard model, Higgs physics, flavor physics and particle cosmology. The conference was greatly successful, providing a nice opportunity to overview the history, current status and future prospects of particle physics.

7.11 MadGraph5_aMC@NLO Femto Workshop



Kentarou Mawatari
Junior Research Professor at Vrije Universiteit Brussel

The workshop was held on March 27, 2015 at the lecture hall of the Kavli IPMU, as a satellite workshop after the KAERU (Key Aspects in Exploring Road to Unification) Conference on March 25-26. [Organizers: Kaoru Hagiwara (KEK), Fabio Maltoni (UCLouvain), Shigeki Matsumoto (Kavli IPMU), Kentarou Mawatari (Vrije U Brussel), and Tim Stelzer (Illinois)].

These days, Monte Carlo event generators are indispensable for reliable theory predictions as well as experimental data analyses at the CERN LHC (Large Hadron Collider), which will resume soon at the upgraded 13 TeV center-of-mass energy, as well as at the ILC (International Linear Collider), which is planned to be built in Japan.

"MadGraph5_aMC@NLO (MG5_aMC in short)" is one of the event generators for high-energy physics, and has been used by many theorists as well as experimentalists. Although MG5_aMC has been maintained and developed for decades mainly by people in Europe and the US, the core code to compute Feynman diagrams (the so-called HELAS: HELicity Amplitude Subroutines) was created by Kaoru Hagiwara (one of the organizers of this workshop), Hitoshi Murayama (Director of the Kavli IPMU), and Isamu Watanabe in 1991. Tim Stelzer (Illinois) and Olivier Mattelaer (Durham) told us this interesting history in the opening address and in the review talk on MG5_aMC, respectively.

In the first half of the workshop, developers introduced their state-of-the-art simulation tools [Benjamin Fuks (Strasbourg): FeynRules2, MadAnalysis5; Olivier Mattelaer (Durham): MadGraph5_aMC@NLO; Barbara Jaeger (Tuebingen): VBFNLO], while Davide Pagani and Eleni Vryonidou (UCLouvain) reported recent progress on the automation of electroweak corrections and loop induced processes, respectively.

In the latter part, we discussed more physics applications based on tools. Chung Kao (Oklahoma) and Tilman Plehn (Heidelberg) talked about the importance of the Higgs-top couplings, while Mihoko Nojiri (KEK/Kavli IPMU) explained her recent paper on jet physics. After the tea break held at Piazza Fujiwara, the workshop resumed with Junichi Kanzaki (KEK), and this author reporting on the GPU project and the Higgs characterisation project, respectively. We also had three talks by young Japanese physicists, Sayaka Kawabata (Tohoku), Junya Nakamura (KEK) and Kohsaku Tobioka (KEK/Tel Aviv/Weizmann), leading to intense and exciting discussions with more than 50 participants from many countries.

The workshop was successfully closed by Fabio Maltoni (UCLouvain), who promised a similar workshop again in the near future. We hope that the workshop provided a valuable opportunity to learn about recent simulation tools and physics at the LHC as well as at the ILC, especially for young people.
We would like to thank Kavli IPMU Director Hitoshi Murayama for his support and the administrative staff members for their kind help.

8 SEMINARS

FY2014

Jacob Wacker (SLAC)
The SIMP Miracle
Apr 01, 2014

Simon Wood (Australian National U)
A working Verlinde Formula for logarithmic CFT
Apr 01, 2014

Jacob Wacker (SLAC)
The Search For New Physics in the LHC Age: Implications of the LHC and the Prospects for the Future
Apr 01, 2014

Bryan Webber (U Cambridge)
Higher-order QCD effects in Higgs boson production
Apr 02, 2014

Peter Goddard (IAS)
Interdisciplinarity and the interplay between mathematics and physics
Apr 02, 2014

Andrew Hearin (Fermilab)
The Dark Side of Galaxy Evolution
Apr 03, 2014

Matthew Roberts (U Chicago)
Response theory of relativistic quantum Hall: A new topological current
Apr 08, 2014

Natsumi Nagata (Kavli IPMU)
Formulation of effective theories for dark matter direct detection
Apr 09, 2014

Khee-Gan Lee (MPIA)
3D Mapping of the IGM on ~Mpc scales with Ly-*α* forest Tomography
Apr 10, 2014

Akishi Ikeda (U Tokyo)
Stability conditions for an N-Calabi-Yau algebra of the A_n-quiver
Apr 14, 2014

Chao-Lin Kuo (Stanford U/SLAC)
BICEP2 results, implications, and future
Apr 14, 2014

Jihun Park (Postech)
Cylinders in smooth del Pezzo surfaces
Apr 15, 2014

Anson Hook (IAS)
S-duality of nonsupersymmetric gauge theories
Apr 15, 2014

Andrew Gerard Akeroyd (U Southanpton)
Decay of charged Higgs bosons into charm and bottom quarks in multi-Higgs doublet models
Apr 16, 2014

Freeman Dyson (IAS)
Can a Single Graviton be Observed?
Apr 16, 2014

Ivan Cheltsov (U Edinburgh)
Cylinders in singular del Pezzo surfaces
Apr 17, 2014

Freeman Dyson (IAS)
Q&A with Freeman Dyson
Apr 17, 2014

Tirasan Khandhawit (Kavli IPMU)
Seiberg-Witten invariants of smooth 4-manifolds
Apr 17, 2014

Edgar Shaghoulian (Stanford U)
Recent advances in dS/CFT
Apr 22, 2014

Ravi Sheth (ICTP)
Cosmology with clusters, voids and their profiles
Apr 24, 2014

Ruben Minasian (CEA Saclay)
Alpha-prime adventures
Apr 24, 2014

Cedric Deffayet (IAP)
Some recent results on massive gravity
Apr 25, 2014

Edgar Shaghoulian (Stanford U.)
Warped entanglement entropy
Apr 28, 2014

Hiroshi Takano (Kavli IPMU)
Multicomponent scenario of WIMP dark matter in the radiative seesaw models
Apr 30, 2014

Roland de Putter (JPL)
Complementarity of weak lensing, galaxy clustering and CMB data: constraints on neutrinos, dark energy and gravity
May 01, 2014

Bryan Webber (U Cambridge)
Precision of Standard Model parameters and Higgs properties
May 07, 2014

Eyal Kazin (Swinburne U of Technology)
Improved distance measurements with reconstructed WiggleZ
May 08, 2014

Daniel Pomerleano (Kavli IPMU)
Homological mirror symmetry for the genus 2 curve
May 08, 2014

Seok Kim (Seoul National U)
General instanton counting and 5d/6d SCFT
May 13, 2014

Michel van Garrel (KIAS)
Relative BPS state counts for toric Del Pezzo surfaces and log mirror symmetry
May 14, 2014

Alexey Tolstov (Kavli IPMU)
Simulations of SNe Ib/c Shock Breakouts using multigroup radiation hydrodynamics
May 15, 2014

Shin Nakamura (Chuo U)
Effective Temperature of Non-equilibrium Steady States in AdS/CFT
May 20, 2014

Takaya Nozawa (NAOJ)
Evolution of dust size distribution and extinction curves in galaxies
May 21, 2014

Sergei Blinnikov (ITEP)
Known and unknown Zeldovich: simplest paths to complexity - from flames to Large Scale Structure
May 22, 2014

Changzheng Li (Kavli IPMU)
On equivariant Pieri rule of isotropic Grassmannians
May 22, 2014

Eiichi Nakano (Osaka City U)
Muon and neutral hadron detection in high energy physics
May 28, 2014

Robert Quimby (Kavli IPMU)
Unusually Bright Supernovae
May 29, 2014

Boris Hasselblatt (Tufts U)
Statistical properties of deterministic systems by elementary means
Jun 03, 2014

Kazunori Nakayama (U Tokyo)
Axion cosmology with high scale inflation
Jun 04, 2014

Jie Zhou (Harvard U)
Counting curves in terms of modular forms
Jun 04, 2014

Sergei Duzhin (Steklov Inst of Mathematics)
On some strange dynamical systems in the real plane
Jun 05, 2014

Haruki Nishino (Kavli IPMU)
CMB B-mode polarization experiments: Recent results from POLARBEAR (and BICEP2)
Jun 05, 2014

Charles Siegel (Kavli IPMU)
Trees and an Affine Cover of \ bar{\mathcal{M}}_{0,n+1}
Jun 05, 2014

Anatol Kirillov (RIMS & Kavli IPMU)
Flag Varieties and Quantum Cohomology, H. Schubert, A. Grothendieck and C. Dunkl
Jun 09, 2014

Matias Zaldarriaga (IAS)
Lecture 1 on primordial non-Gaussianity
Jun 09, 2014

Matias Zaldarriaga (IAS)
Lecture 2 on primordial non-Gaussianity
Jun 09, 2014

Achilleas Porfyriadis (Harvard U)
Gravity waves from Kerr/CFT
Jun 10, 2014

Matias Zaldarriaga (IAS)
Discussion meeting
Jun 10, 2014

Tetsutaro Higaki (KEK)
Natural inflation models in string-inspired supergravity
Jun 11, 2014

Matias Zaldarriaga (IAS)
The CMB after 50 yrs, from discovery to BICEP 2
Jun 11, 2014

Kazuki Sakurai (KCL)
ATOM/Fastlim: Recasting LHC constraints on new physics models
Jun 12, 2014

Matias Zaldarriaga (IAS)
Lecture 1 on Effective field theory of large-scale structure
Jun 12, 2014

Hee-Jong Seo (OSU)
High precision cosmology with BAO surveys: BOSS and future 21cm BAO surveys
Jun 12, 2014

Matias Zaldarriaga (IAS)
Lecture 2 on Effective field theory of large-scale structure
Jun 12, 2014

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Florian Beutler (LBNL)
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Michihisa Takeuchi (KCL)
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Roberto Emparan (Barcelona U.)
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Atsushi Naruko (Titech)
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Reynald Pain (LPNHE, Université Pierre et Marie Curie)
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Benny Traktenbrot (ETH-Zurich)
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Djordje Radicevic (Stanford U)
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Alexander Kusenko (Kavli IPMU/UCLA)
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Mukund Rangamani (Durham U)
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Dionysis Anninos (IAS)
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Mariana Orellana (Universidad Nacional de Río Negro)
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Anatoly Libgober (U Illinois, Chicago)
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Tokyo Metropolitan U, Mathematics
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Akhlaghi, Mohammad
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Asano, Tomohiro
U Tokyo, Math Sci, Mathematics
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Atal, Vicente
Leiden U, Particle Theory
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Audren, Benjamin
EPF Lausanne, Cosmology
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FSUE VNIIA
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Badjin, Dimitry
ITEP
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Baer, Howard
U Okulahoma
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Baklanov, Petr
ITEP
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Bamba, Kazuharu
Ochanomizu U, Cosmology
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Bamford, Stevan
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Barberio, Elisabetta
U Melbourne, Particle Theory
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Barkov, Maxim
RIKEN
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Barnabè, Matteo
U Copenhagen, Cosmology
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Baroncelli, Tommaso
U Melbourne
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Barr, Giles
U Oxford, Particle Theory
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Begelman, Mitchell C
U Colorado Boulder, Astrophysics
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Behrens, Annika
UZH
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Berger, Bruce
Colorado State U, Neutrino Physics
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Betoule, Marc
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Bettarini, Stefano
INFN-Pisa, High Energy Physics
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Beutler, Florian
LBL, Berkeley, Astrophysics
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Bitoun, Thomas
HSE, Mathematics
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Blaes, Omer
UC Santa Barbara, Astrophysics
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Blinnikov, Sergei
ITEP, Astronomy
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Bodzenta-Skibinska, Agnieszka Maria
U Warsaw, Mathematics
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Bolognesi, Sara
CEA-Saclay
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Bosch, Jim
Princeton U, Astrophysics
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Bouche, Nicolas
IRAP, Astrophysics
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IAP, Astrophysics
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Bousso, Raphael
UC Berkeley, Cosmology
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Bradač, Maruša
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Buchsteiner, Florian
HEPHY, Austrian Academy of Sciences, High Energy Physics
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Buchweitz, Ragnar
U Toronto, Mathematics
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U Edingurgh
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Bunker, Andrew
U Oxford, Astrophysics
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Bureau, Martin Gilles
U Oxford, Astrophysics
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McMaster U, Particle Theory
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U Arizona, Astronomy
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Calore, Francesca
U Amsterdam/GRAPPA, Astronomy
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U Hawaii, Astronomy
2014/11/06–11/16

Catanesi, Maria Gabriella
INFN Bari
2015/01/28–01/31

Catania, Miguel Arana
UAM, Theoretical Physics
2014/01/15–04/05

Ceccanti, Marco
INFN-Pisa, High Energy Physics
2014/06/16

Chakraborty, Chandrachur
Saha Institute of Nuclear Physics, Cosmology
2014/11/10–11/14, 2015/03/29–04/10

Chantraine, Baptiste
U Nantes, Mathematics
2014/04/21–04/24

Cheltsov, Ivan
U Edinburgh, Mathematics
2014/04/13–04/20

Chen, Heng-Yu
Natl Taiwan U, String Theory
2015/02/03–02/04

Chen, Hsin-Yu
U Chicago, Astronomy
2014/04/01–04/02

Chendra, Roy
Tokyo Tech
2014/10/27–10/31

Chendvankar, Sanjay Rajaram
Tata Inst, High Energy Physics
2014/07/01–07/26, 11/20–12/20, 2015/01/31–02/21

Cherman, Aleksey
FTPI, Particle Theory
2014/11/03–11/07

Cheung, Kingman
Natl Tsing Hua U
2015/03/25–03/26

Chiang, Cheng-Wei
National Central University, Particle Theory
2015/02/23–08/23

Chiang, Chi-Ting
MPI for Astrophysics, Astronomy
2014/12/08–12/12

Chiang, River
NCKU, Mathematics
2014/04/20–04/25

Chiba, Junsei
Tokyo U of Science
2014/11/11

Chiba, Takeshi
Nihon U, Cosmology
2014/11/10–11/14

Chinone, Yuji
KEK, Astronomy
2014/08/29, 10/26–10/31

Cho, Gi-Chol
Ochanomizu U, High Energy Physics
2015/03/25–03/27

Choi, Jun Ho
Dongshin U, Neutrino Physics
2015/01/28–01/31

Choi, Junhwan
U Texas, Astronomy
2014/04/06–04/11

Choi, Seong Youl
CBNU
2015/03/25–03/27

Chon, Sunmyon
U Tokyo, Astrophysics
2014/04/07–04/11

Christiansen, Jessie
NEXSCI,, Astrophysics
2014/06/22–06/28

Coe, Dan
Space Telescope Science Institute, Astronomy
2014/11/16–11/22

Colin, Vincent
U Nantes, Mathematics
2014/04/21–04/24

Connolly, Kevin T
U Washington, Seattle, Experimental Physics
2013/12/27–2014/04/30, 05/12–08/01

Cooper, Michael
UC Irvine
2015/02/01–02/08

Cordova, Clay
Harvard U, Mathematics
2014/09/28–10/02

Courbin, Frédéric
EPF Lausanne, Astrophysics
2014/11/16–11/22

Cox, Graham
UNC, Chapel Hill, Mathematics
2014/10/22–10/26

Cremonesi, Linda
QMUL
2015/01/28–01/31

Croker, Kevin Arthur Schiff
U Hawaii, Astronomy
2014/06/17–08/19

Dainotti, Maria
RIKEN, Astronomy
2014/11/06

Dalal, Neal K
U Illinois, Urbana, Astrophysics
2014/11/20–12/06

Damian, Mihai
U Strasbourg, Mathematics
2014/04/21–04/24

Damjanov, Ivana
Harvard U, CfA
2015/01/31–02/07

Das, Sumit Ranjan
U Kentucky, String Theory
2014/07/13–07/15

Davis, Shane
CITA, Astrophysics
2014/04/06–04/12

de Putter, Roland
NASA JPL/Caltech, Astrophysics
2014/04/19–05/03

de Rham, Claudia
CWRU, Cosmology
2014/11/09–11/12

De Rosa, Gianfranca
INFN-Naples
2015/01/28–01/31

Decowski, Patrick
U Amsterdam/GRAPPA, Neutrino Physics
2014/11/16–11/26

Deffayet, Cedric
U Paris 7, Cosmology
2014/04/23–04/25

DeGraf, Colin
Herbrew U, Astrophysics
2015/01/31–02/04

Delabrouille, Jacques
CNRS, Astroparticle Physics
2014/10/29

Deno, Yuya
U Tokyo, RESCEU
2014/10/27–10/31

Dewhurst, Debra
U Oxford, Neutrino Physics
2015/01/28–01/31

Di Lodovico, Francesca
QMUL, High Energy Physics
2015/01/28–01/31

Dimofte, Tudor
IAS, String Theory
2015/03/23–03/27

Doi, Takumi
RIKEN
2014/11/06

Domenech, Guillem
Kyoto U
2014/11/10–11/14

Drees, Manuel
U Bonn
2015/03/25–03/26

Durrer, Ruth
U Geneva, Cosmology
2014/07/07–07/09

Duzhin, Sergei
PDMI, Mathematics
2014/05/01–06/30

Dyson, Freeman
IAS, Theoretical Physics
2014/04/15–04/23

Eda, Kazunari
U Tokyo, RESCEU, Astrophysics
2014/11/10–11/14

Edelmann, Philipp
Max Plank Institute for Astrophysics, Garching, Astrophysics
2015/01/17–01/30

Efremenko, Yuri
U Tennessee, Neutrino Physics
2014/06/22–07/02

Eguchi, Toru
Rikkyo U
2014/11/06

Eiichi, Nakano
Osaka City U., High Energy Physics
2014/05/28

Eijima, Shintaro
EPFL
2015/03/25–03/26

Ellis, John
King's College London, Particle Theory
2014/06/29–07/01

Emparan, Roberto
U Barcelona, String Theory
2014/07/09

Endo, Hisaaki
Tokyo Tech, Mathematics
2014/04/21–04/24

Enomoto, Sanshiro
U Washington, Seattle, Neutrino Physics
2014/05/16–05/31, 08/23–09/03

Enoto, Teruaki
RIKEN
2014/12/24–12/25

Erler, Theodore
LMU Munich, String Theory
2014/09/28–10/03

Evans, Jason Lott
U Minnesota, Particle Theory
2014/06/13–06/29

Evslin, Jarah
Institute of Modern Physics, CAS
2015/03/25–03/26

Faonte, Giovanni
Yale Univ., Mathematics
2014/09/01–2016/08/31

Fassnacht, Christopher D
UC Davis, Cosmology
2014/11/16–11/22

Fedrow, Joseph M
UC San Diego, Particle Theory
2014/07/14–07/16

Fejos, Gergely
RIKEN
2014/11/06

Ferrandiz, Carlos Moraga
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Ferré-Mateu, Anna
NAOJ, Hawaii, Astronomy
2014/09/22, 2015/02/01–02/09

Feusels, Tom
U British Columbia, Neutrino Physics
2015/01/28–01/31

Fiorentini, Arturo
York University, Neutrino Physics
2015/01/28–01/31

Flaminio, Raffaele
NAOJ, Astronomy
2014/11/10–11/14

Fodor, Zoltan
Bergische Universitat Wuppertal
2015/03/25–03/26

Font-Ribera, Andreu
Lawrence Berkeley National Laboratory, Astronomy
2015/03/08–03/17

Forti, Francesco
INFN-Pisa
2014/06/16, 10/31–11/03, 11/07–11/11

Fragile, Chris
College of Charleston, Astrophysics
2014/04/06–04/12

Francesca, Borzumati
SISSA
2015/03/25–03/26

Frauenfelder, Urs
Seoul Natl U, Mathematics
2014/04/21–04/24

Friedl, Markus
HEPHY, Austrian Academy of Sciences, High Energy Physics
2014/06/16, 10/30–11/01, 11/07–11/11

Friend, Megan Lynn
KEK, Experimental Physics
2015/01/28–01/31

Fujii, Keisuke
KEK
2015/03/25–03/26

Fujii, Shunsuke
Kuji Technical high school
2014/10/27–10/31

Fujii, Yoshiaki
KEK
2015/01/28–01/31

Fujikawa, Brian
LBL, Berkeley, Neutrino Physics
2014/04/01–04/02, 11/22–12/03

Fujimoto, Koichi
Osaka U
2014/11/06

Fujino, Takuro
YNU
2014/09/30, 10/27–10/31, 11/26–11/27, 12/04, 12/22, 2015/01/08, 01/15, 01/22–01/23, 01/29

Fujioka, Norihisa
SEIKO EG&G, Neutrino Physics
2015/01/28–01/31

Fujita, Hiroyuki
U Tokyo, ISSP
2014/11/06

Fujita, Mitsutoshi
Kyoto U, Particle Theory
2014/04/01–04/25, 10/27–11/01

Fuke, Hideyuki
JAXA, Particle Theory
2015/01/21

Fuks, Benjamin
IPHC
2015/03/25–03/27

Fukuda, Daisuke
Okayama U, Neutrino Physics
2015/01/28–01/31

Fukui, Takao
IAU, Astronomy
2014/11/06

Fukushima, Hajime
Kyoto U
2014/11/10–11/14

Fukuzumi, Yoshiki
U Tokyo, ISSP
2014/11/06

Furui, Sadataka
Teikyo U, Particle Theory
2015/03/04–03/06

Furukawa, Ryo
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Furusaki, Akira
RIKEN, Condensed Matter Physics
2014/11/06

Gaitsgory, Dennis
Harvard U, Mathematics
2014/11/22–11/29

Gao, Xian
Tokyo Tech, Cosmology
2014/11/10–11/14

Genel, Shy
Columbia U
2015/02/01–02/07

Goda, Hiroshi
Tokyo U of Agriculture and Tech, Mathematics
2014/04/21–04/24

Godbole, Rohini M
Indian Institute of Science, High Energy Physics
2015/03/25–03/26

Goddard, Peter
IAS, Mathematical Physics
2014/03/26–04/03

Gomar, Laura Castell
EM-CSIC
2014/11/11–11/14

Gonin, Michel
Laboratoire Leprince-Ringuet, Neutrino Physics
2015/01/28–01/31

Greene, Jenny
Princeton U, Astronomy
2015/01/29–02/07

Grumiller, Daniel
TU Vienna, String Theory
2015/01/19–01/30

Gubser, Steven
Princeton U, High Energy Physics
2014/11/10–11/14

Haba, Naoyuki
Shimane U
2015/03/25–03/26

Hada, Ryuichiro
Tohoku U
2014/10/27–10/31

Hadley, David
U Warwick, High Energy Physics
2015/01/28–01/31

Haeussler, Boris
U Oxford
2015/01/31–02/08

Hagiwara, Chisaki
Hirosaki U
2014/11/09–11/14

Hagiwara, Kaoru
KEK, Particle Theory
2015/03/25–03/27

Haino, Sadakazu
Institute of Physics, Academia Sinica, Particle Theory
2014/10/17

Hamaguchi, Koichi
U Tokyo, Particle Theory
2015/03/04–03/06, 03/25–03/26

Hamuy, Mario
U Chile, Astronomy
2014/10/10, 10/16–10/17

Han, Chengcheng
APCTP, Theoretical Physics
2014/12/14–12/20

Han, Tao
U Wisconsin, Madison
2015/03/25–03/27

Hara, Koji
KEK, Particle Theory
2014/04/03, 04/07, 04/10, 04/15–04/17, 04/22, 04/25, 04/28, 05/01, 05/08–05/09, 05/13, 05/15–05/16, 05/20, 06/10, 06/12–06/13, 06/16, 06/26, 07/01–07/02, 07/04, 07/08, 07/19, 07/22, 07/25, 07/28–07/29, 07/31–08/02, 08/05, 08/07–08/08, 08/11–08/12, 08/19, 08/26, 09/01, 09/09, 09/11, 09/18–09/19, 09/25–09/26, 10/16, 10/20, 10/24, 10/27, 10/31, 11/11, 11/25, 12/03, 12/12, 12/18, 12/26, 2015/01/07, 01/14, 01/16, 01/29, 02/05, 02/16–02/17, 03/05–03/06, 03/09–03/12, 03/18–03/20, 03/24–03/27

Harada, Akira
U Tokyo, Astrophysics
2014/04/10–04/11

Harada, Naoya
Hirosaki U
2014/11/09–11/14

Harada, Tomohiro
Rikkyo U, Mathematical Physics
2014/11/10–11/14

Hartz, Mark Patrick
U Tokyo, IPMU, Neutrino Physics
2015/03/23–03/29

Hasegawa, Kaori
Nara Women's U
2014/05/09

Hashimoto, Akikazu
U Wisconsin, Madison, String Theory
2014/09/01, 2015/01/06–01/10

Hashimoto, Ichihiko
Kyoto U, Particle Theory
2014/10/27–10/31, 11/10–11/14

Hashimoto, Koji
Osaka U, Particle Theory
2014/11/06

Hasselblatt, Boris
Tufts U, Mathematics
2014/06/03

Hatsuda, Machiko
Chuo U
2015/01/19

Hatsuda, Tetsuo
RIKEN, Nuclear Physics
2014/11/06

Hayakawa, Taku
U Tokyo, ICRR, Particle Theory
2014/11/06, 2015/03/04–03/06

Hayashi, Kohei
Tohoku U, Astronomy
2015/01/19–01/20

Hayashinaka, Takahiro
U Tokyo, RESCEU, Astrophysics
2014/10/27–10/31, 11/10–11/14

Hayato, Yoshinari
U Tokyo, ICRR, Neutrino Physics
2015/01/28–01/31

He, Song
Kyoto U, String Theory
2014/08/16–08/22

He, Weiqiang
Sun Yat-sen University, Mathematics
2014/08/25–08/27

Hearin, Andrew
Fermilab, Cosmology
2014/03/30–04/12

Henning, Brian
UC Berkeley, Particle Theory
2014/07/22–08/26

Hennion, Benjamin
U Montpellier, Mathematics
2014/11/30–12/07

Hezaveh, Yashar
KIPAC, Astrophysics
2014/11/16–11/22

Hidaka, Yoshimasa
RIKEN
2014/11/06

Higaki, Tetsutaro
KEK, Particle Theory
2014/06/11

Hikasa, Ken-ichi
Tohoku U
2015/03/25–03/26

Hilbert, Stefan Johannes
MPI for Astrophysics, Astrophysics
2014/11/16–11/22

Himmel, Alexander I.
Duke U, High Energy Physics
2015/01/28–01/31

Hirai, Shiro
Osaka Electro-Communication U
2015/03/25–03/26

Hirakawa, Takumi
Hiroshima University
2014/10/27–10/31

Hiramatsu, Takashi
Kyoto U, Cosmology
2014/11/10–11/14

Hirose, Shigenobu
JAMSTEC, Astrophysics
2014/04/07–04/11

Hirota, Seiko
Kyoto U, Neutrino Physics
2015/01/28–01/31

Hirotani, Kouichi
ASIAA, Astrophysics
2014/10/01

Hisano, Junji
Nagoya U, Particle Theory
2015/03/25–03/26

Hiyama, Emiko
RIKEN
2014/11/06

Holman, Richard
Carnegie Mellon U, Cosmology
2014/09/19–09/28

Honda, Ko
U Southern California, Mathematics
2014/04/21–04/24

Hongo, Masaru
U Tokyo
2014/11/06

Hook, Anson
IAS, Particle Theory
2014/04/12–04/18

Hopkins, Philip
TAPIR,, Astrophysics
2014/06/22–06/28

Horiguchi, Tomohiro
Tohoku U
2014/04/18, 05/23, 05/25–05/29, 06/01–06/13, 06/25–06/26, 07/01–07/10, 07/22–07/28, 08/11–08/12, 08/18–08/26, 09/24–10/02, 11/09–11/11, 2015/01/19–01/22, 01/30, 02/23–02/24, 02/27–03/06, 03/17–03/19

Horikoshi, Masaatsu
Shinshu U
2014/11/10–11/14

Hosaka, Atsushi
Osaka U
2014/11/06

Hoshino, Hanako
Nagoya U, Cosmology
2014/04/21–04/25, 06/02–06/11, 08/04–08/12, 10/06–10/10, 11/10–11/14, 12/01–12/05, 2015/01/22–01/31

Hosokawa, Takashi
U Tokyo, Astrophysics
2014/04/07–04/11

Hotta, Kenji
Hokkaido U, Particle Theory
2014/11/09–11/14

Houri, Tsuyoshi
Kobe U, Cosmology
2014/11/10–11/14

Hu, Wayne
KICP, Cosmology
2014/12/07–12/24

Huang, Da
Natl Tsing Hua U, Particle Theory
2014/11/13–11/15

Huang, Kunxian
Kyoto U, Neutrino Physics
2015/01/28–01/31

Hubeny, Veronica
Durham U, String Theory
2015/01/08

Huertas-Company, Marc
Observatory of Paris
2015/01/31–02/08

Hung, Janet Ling-Yan
Fudan U, String Theory
2014/12/14–12/21

Igata, Takahisa
Kwansei Gakuin U
2014/11/10–11/14

Igi, Keiji
RIKEN, Particle Theory
2015/03/25–03/26

Iitaka, Toshiaki
RIKEN
2014/11/06

Ikeda, Akishi
U Tokyo, Math Sci, Mathematics
2014/04/14

Ikeda, Motoyasu
U Tokyo, ICRR, High Energy Physics
2015/01/28–01/31

Ikeda, Taishi
Nagoya U
2014/11/10–11/14

Imber, James
Laboratoire Leprince-Ringuet, Experimental Physics
2015/01/28–01/31

Inami, Takeo
Natl Taiwan U, Field Theory
2014/11/10–11/14

Inoue, Yoshiyuki
KIPAC, Astrophysics
2014/04/07–04/11

Ioka, Kunihito
KEK, Particle Theory
2014/11/10–11/14

Irie, Fumiya
YNU
2014/04/14, 05/23, 06/16, 09/30, 10/27–10/31, 11/13, 12/03, 12/18, 2015/01/21, 02/18

Irie, Kei
Kyoto U, Mathematics
2014/04/20–04/24

Iritani, Hiroshi
Kyoto U, Mathematics
2015/01/08–01/13, 03/15–03/20

Iriyeh, Hiroshi
Tokyo Denki U, Mathematics
2014/04/21–04/24

Irmler, Christian
HEPHY, Austrian Academy of Sciences, High Energy Physics
2014/06/16, 10/30–11/01, 11/07–11/11

Iseki, Kouta
Hirosaki U
2014/11/09–11/14

Ishibashi, Akihiro
Kinki U, Cosmology
2014/11/10–11/12

Ishida, Hiroyuki
Shimane U, Particle Theory
2015/03/25–03/27

Ishida, Taku
KEK, High Energy Physics
2015/01/28–01/31, 03/25–03/26

Ishihara, Hideki
Osaka City U
2014/11/10–11/14

Ishikawa, Akimasa
Tohoku U, High Energy Physics
2014/04/10, 04/18, 05/23

Ishikawa, Suguru
Kyoto U, Mathematics
2014/04/21–04/24

Ishikawa, Takashi
Kyoto U, Astronomy
2014/10/27–10/31

Ishio, Kazuma
U Tokyo, ICRR
2014/11/06

Ishitsuka, Masaki
Tokyo Tech, Neutrino Physics
2015/01/28–01/31

Ismail, Ahmed
Argonne national lab, Theoretical Physics
2014/09/06–09/13

Iso, Satoshi
KEK, Particle Theory
2015/03/25–03/26

Isseki, Yu
RIKEN
2014/11/06

Ito, Hirotaka
RIKEN, Astrophysics
2014/11/06

Itoh, Tetsuya
Kyoto U, Mathematics
2014/04/20–04/23

Itow, Yoshitaka
Nagoya U, Neutrino Physics
2015/01/28–01/31

Iudin, Andrei
ITEP
2014/11/03–11/09

Iwasa, Mao
Kyoto U, Astrophysics
2014/11/09–11/14

Iwasaki, Masako
KEK, High Energy Physics
2015/03/09

Izawa, Ken'ichi
Kyoto U, Particle Theory
2014/04/14–04/15, 06/04–06/06, 07/15–07/17, 07/28–07/30, 08/28–08/29, 09/08–09/10, 10/09–10/10, 10/30–10/31, 11/26–11/28, 2015/01/08–01/09, 02/19–02/20

Izubuchi, Taku
BNL
2015/03/25–03/26

Izumi, Keisuke
Natl Taiwan U, Cosmology
2014/08/18–08/27

Izumi, Koji
Hirosaki U
2014/11/09–11/15

Jaelani, Anton Timur
Tohoku U
2014/11/09–11/21

Jager, Barbara
U Tuebingen, Particle Theory
2015/03/25–03/27

Jain, Rajeev Kumar
USD, Cosmology
2014/11/01–11/15

James Wood, Simon
ANU, Mathematical Physics
2014/03/31–04/04

Jarv, Laur
University of Tartu
2014/11/08–11/16

Jauzac, Mathilde
Durham U, Astronomy
2014/11/16–11/22

JEE, Inh
MPI for Astrophysics, Astrophysics
2014/11/17–11/21

Jensen, Kristan
SUNY, Stony Brook, String Theory
2014/11/12

Jeon, Hyebin
Kyungpook National U, High Energy Physics
2014/06/23–06/29, 07/22–08/31, 2015/01/12–02/20

Jeong, Kwang Sik
IBS, Particle Theory
2014/11/17–11/20

Jiang, Miao
Kyoto U, Neutrino Physics
2015/01/28–01/31

Jiang, Yenfei
Harvard U, CfA, Astronomy
2014/04/06–04/10

Johansson, Robert
RIKEN
2014/11/06

Jones, Samuel
U Victoria, Astronomy
2014/11/18–11/28, 2015/01/17–01/30

Jonsson, Per
Imperial Coll. London
2015/01/28–01/31

Kabirnezhad, Monireh
NCBJ
2015/01/28–01/31

Kachulis, Christopher
Boston U, High Energy Physics
2015/01/28–01/31

Kahn, Steven
SLAC, Cosmology
2014/06/29–07/01

Kalman, Tamas
Tokyo Tech, Mathematics
2014/04/24

Kamada, Ayuki
UC Riverside, Particle Theory
2015/02/19–02/20, 02/22–02/27

Kamada, Kohei
EPF Lausanne, Cosmology
2014/11/10–11/14

Kameda, Jun
U Tokyo, ICRR, Neutrino Physics
2015/01/28–01/31

Kamikado, Kazuhiko
RIKEN
2014/11/06

Kaminski, Matthias
U Washington, Seattle, String Theory
2014/12/09

Kamiya, Yoshitomo
RIKEN
2014/11/06

Kanazawa, Takuya
RIKEN, Particle Theory
2014/11/06

Kanbara, Naoya
Tokyo U of Science
2014/11/11, 11/14, 11/17–11/19, 11/21, 11/25–11/26, 12/01–12/03, 12/09–12/12, 12/15–12/19, 2015/01/19–01/22, 01/30, 02/18–02/20

Kanemura, Shinya
U Toyama
2015/03/25–03/26

Kaneta, Kunio
U Tokyo, IPMU, Particle Theory
2014/10/16–11/02, 11/06, 2015/03/04–03/06, 03/25–03/26

Kang, KookHyun
Kyungpook National U, High Energy Physics
2014/06/23–08/31, 2015/01/12–02/20

Kanzaki, Junichi
KEK
2015/03/25–03/26, 2015/03/27

Kao, Chung
U Okulahoma
2015/03/25–03/26, 2015/03/27

Karakas, Amanda Irene
Australian Natl U, Astronomy
2014/11/18–11/29

Karatsu, Kenichi
NAOJ
2014/10/27–10/31

Karch, Andreas
U Washington, Seattle, String Theory
2014/06/19–06/20

Karciauskas, Mindaugas
KEK
2015/03/04–03/06

Kase, Ryota
Tokyo U of Science
2014/11/10–11/14

Kashino, Daichi
Nagoya U, Astronomy
2014/04/21–05/02, 07/14–07/26, 08/25, 09/05–09/11, 10/06–10/11, 2015/01/15–01/30, 02/16, 03/02, 03/06–03/08

Kashiwagi, Toshiya
U Tokyo
2015/02/20

Kasuya, Naohiko
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Katori, Teppei
QMUL, Neutrino Physics
2015/01/28–01/31

Katsuragawa, Taishi
Nagoya U
2014/11/10–11/14

Kawabata, Sayaka
Tohoku U, Particle Theory
2015/03/25–03/27

Kawai, Shinsuke
Sungkyunkwan U, String Theory
2014/11/10–11/13

Kawai, Yoshihiko
Hamamatsu Photonics, High Energy Physics
2015/01/28–01/31

Kawakami, Etsuko
U Tokyo, ICRR, Particle Theory
2014/10/16–11/02

Kawamura, Hiroyuki
Juntendo University
2015/03/25–03/26

Kawanaka, Norita
U Tokyo, Astrophysics
2014/04/07–04/11

Kawasaki, Masahiro
U Tokyo, ICRR, Cosmology
2014/11/10–11/14, 2015/03/04–03/06

Kawasaki, Morimichi
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Kawasaki, Takeo
Niigata U., High Energy Physics
2014/05/22–05/23, 2015/03/12

Kazin, Eyal
Swinburne University of Technology, Astrophysics
2014/05/06–05/13

Kearns, Edward T
Boston U, Neutrino Physics
2015/01/28–01/31

Keeton, Charles R
Rurgers U, Piscataway, Astrophysics
2014/11/17–11/21

Kehayias, John Fotis
, Particle Theory
2014/09/16–09/23

Kerzendorf, Wolfgang
European Southern Observatory, Astronomy
2014/08/18–08/23

Khabibullin, Marat
INR RAS, High Energy Physics
2015/01/28–01/31

Khangulyan, Dmitry
JAXA, Astrophysics
2014/04/07–04/11

Kiessling, Alina
NASA JPL/Caltech, Astronomy
2014/10/27–10/31

Kikuchi, Daiki
Hirosaki U
2014/11/09–11/14

Kim, Bobae
Kyungpook National U, High Energy Physics
2015/02/13–02/20

Kim, Eunjong
RIKEN
2014/11/06

Kim, Hyunkyu
KIAS, Mathematics
2014/10/14–10/23

Kim, Seok
Seoul Natl U, Particle Theory
2014/05/12–05/14

Kim, Soo-Bong
Seoul Natl. U., Experimental Physics
2015/01/28–01/31

Kim, Young-Kee
Fermilab, High Energy Physics
2014/06/29–07/02

Kim, C. S
Yonsei U, Particle Theory
2015/03/25–03/26

Kim, Keun Young
GIST, String Theory
2014/11/25–11/26

Kimura, Masashi
U Cambridge
2014/11/09–11/15

Kinoshita, Shunichiro
Osaka City U, Mathematical Physics
2014/11/09–11/14

Kirillov, Anatol N
Kyoto U, Mathematics
2014/05/20–06/19

Kitajima, Naoya
Tohoku U, Astrophysics
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Kitamura, Takao
Hirosaki U
2014/11/09–11/14

Kitamura, Tomotaka
Waseda U, Cosmology
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kitazawa, masakiyo
Osaka U, Astrophysics
2014/11/06

Kitazawa, Noriaki
Tokyo Metropolitan U
2015/03/25–03/26

Kiuchi, Kenta
Kyoto U, Astrophysics
2014/11/09–11/15

Kiyo, Yuichiro
Juntendo University
2015/03/25–03/26

Ko, Pyungwon
KIAS, High Energy Physics
2015/03/25–03/27

Kobayashi, Chiaki
CAR, U of Hertfordshire, Astronomy
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Kobayashi, Masato
Nagoya U, Astrophysics
2014/04/14–04/25, 06/02–06/04, 06/09–06/13, 08/04–08/15, 09/17–09/26, 11/20–11/28, 2015/01/26–01/30

Kobayashi, Takashi
KEK, High Energy Physics
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Kobayashi, Tsutomu
Rikkyo U, Cosmology
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Kodali, Kameswara Rao
Tata Inst, High Energy Physics
2014/06/15–07/26, 09/17–10/17, 11/16–12/20, 2015/01/11–02/21

Kodama, Hideo
KEK, Cosmology
2014/11/10–11/14

Koga, Yasutaka
Rikkyo U
2014/11/10–11/14

Kohri, Kazunori
KEK, Cosmology
2014/04/07–04/11

Koizumi, Yuto
Osaka Prefecture U
2014/10/27–10/31

Kojima, Sadayoshi
Tokyo Tech, Mathematics
2014/06/30

Kojima, Yasufumi
Hiroshima U, Astrophysics
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Kokubu, Takafumi
Rikkyo U
2014/11/10–11/14

Komarov, Stanislav
NPCMAPRO, Mathematics
2014/11/01–11/09

Komatsu, Eiichiro
MPI for Astrophysics, Cosmology
2014/10/27–12/26

Konaka, Akira
TRIUMF, Neutrino Physics
2015/01/28–01/31

Konno, Hokuto
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Konno, Kohkichi
National Institute of Technology, Tomakomai Collage
2014/11/10–11/12

Koopmans, Leon V.E
U Groningen, Cosmology
2014/11/17–11/21

Koseki, Tadashi
KEK
2015/01/28–01/31

Koshio, Yusuke
Okayama U, Neutrino Physics
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Kotani, Masahiro
Hamamatsu Photonics
2015/01/28–01/31

Krolik, Julian
Johns Hopkins U, Astrophysics
2014/04/07–04/12

Kubota, Takahiro
Osaka U, String Theory
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Kudenko, Yury
INR RAS, Neutrino Physics
2015/01/28–01/31

Kuncarayakti, Hanindyo
U Chile, Astronomy
2014/09/11–09/29

Kundu, Anirban
U of Calcutta, Particle Theory
2014/11/23–12/07

Kuniba, Atsuo
U Tokyo, Mathematical Physics
2015/02/10

Kunimitsu, Taro
U Tokyo, RESCEU, Astrophysics
2014/11/10–11/14

Kuo, Chao-Lin
Stanford U, Cosmology
2014/04/14

Kurita, Yasunari
Kanagawa Institute of Technology
2014/11/11–11/14, 2015/03/04–03/06

Kuroki, Shintaro
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Kurosawa, Gen
RIKEN
2014/11/06

Kuroyanagi, Sachiko
U Tokyo, RESCEU, Cosmology
2014/10/27–10/31

Kusaka, Akito
Princeton U
2014/08/08

Kusenko, Alexander
UCLA, Particle Theory
2014/10/10–12/17

Kuwabara, Hirosuke
Tokyo Metropolitan U
2015/03/04–03/06

Kuze, Masahiro
Tokyo Tech, High Energy Physics
2015/01/28–01/31

Kyushima, Hiroyuki
Hamamatsu Photonics, Neutrino Physics
2015/01/28–01/31

L'Huillier, Benjamin Pierre Emmanuel
KIAS
2014/04/14–04/15

Labarga, Luis
UAM, High Energy Physics
2015/01/28–01/31

Lagoda, Justyna
NCBJ
2015/01/28–01/31

Lambard, Guillaume Alexandre Marc
IBS, Astroparticle Physics
2014/11/10–11/14

Lani, Caterina
Tel Aviv U
2015/01/31–02/07

Laporte, Chervin
Columbia U
2015/01/30–02/10

Lawe, Matthew
U Sheffield
2015/01/28–01/31

Lee, Adrian
UC Berkeley, Cosmology
2014/10/29

Lee, Jooyoung
KIAS
2014/11/06

Lee, Kelvin
U Innsbruck
2015/01/31–02/07

Lee, Khee-Gan
MPI for Astronomy, Astronomy
2014/04/06–04/13

Lee, Shiu-Hang Herman
JAXA, Astrophysics
2014/11/06

Lee, Jae Sik
Chonnam National U
2015/03/25–03/26

Lesgourgues, Julien
CERN, Cosmology
2014/10/25–11/01

Leung, Shing Chi
CUHK, Astronomy
2015/03/04–05/30

Li, Changzheng
IBS, POSTECH, Mathematics
2014/12/16–12/27, 2015/03/14–03/17

Li, Hsiang-nan
Institute of Physics, Academia Sinica, Particle Theory
2015/03/25–03/26

Libgober, Anatoly
University of Illinois, Mathematics
2015/03/08–03/14

Lilly, Simon
ETH Zurich, Astronomy
2015/02/01–02/08

Lim, In Taek
Chonnam National U, High Energy Physics
2015/01/28–01/31

Lin, Chunshan
Kyoto U, Cosmology
2014/11/10–11/14, 12/22–12/26

Linder, Eric
LBL, Berkeley, Astrophysics
2014/07/09–07/15

Lindner, Thomas
TRIUMF, Neutrino Physics
2015/01/28–01/31

Litchfield, Phillip
UCL
2015/01/28–01/31

Ludwig, Judith
Imperial Coll., London, Mathematics
2014/10/21

Lupton, Robert
Princeton U, Astronomy
2014/10/26–11/01

Ma, Kai
KEK, Particle Theory
2015/03/25–03/27

Ma, Wing Yan
Imperial Coll. London
2015/01/28–01/31

MacPherson, Andrew
IHES, Mathematics
2014/08/09–08/12

Maeda, Kazuki
RIKEN
2014/11/06

Maeda, Kei-ichi
Waseda U, Cosmology
2014/11/11–11/14

Maeda, Keiichi
Kyoto U, Astrophysics
2014/09/22

Maeda, Shouji
Tokyo U of Science, Mathematics
2014/04/21–04/24

Maekawa, Nobuhiro
Nagoya U
2015/03/25–03/26

Malek, Matthew
Imperial Coll. London, Neutrino Physics
2015/01/28–01/31

Maltoni, Fabio
CP3
2015/03/25–03/27

Mammini, Paolo
INFN-Pisa, High Energy Physics
2014/06/16

Mancini, Chiara
Universita' di Padova
2015/02/01–02/07

Manjarrez-Gutierrez, Fabiola
CIMAT, Mathematics
2014/04/19–04/25

Mao, Shude
Chinese Academy of Sciences, Cosmology
2014/11/16–11/22

Marchesini, Danilo
Tufts U, Astronomy
2015/01/28–02/08

Marsan, Cemile
Tufts U
2015/02/01–02/09

Marshakov, Andrei
HSE, String Theory
2014/09/13–09/16

Marshall, Philip James
U Oxford, Cosmology
2014/11/16–11/22

Mart, Terry
U Indonesia
2014/11/06

Martin, John
U Toronto, Experimental Physics
2015/01/28–01/31

Maru, Nobuhito
Osaka City U, Particle Theory
2015/03/25–03/26

Marugan, Guillermo A. Mena
EM-CSIC
2014/11/11–11/14

Mathew, Titus K
Cochin U
2014/11/09–11/15

Matsumoto, Jin
RIKEN
2014/11/06

Matsumura, Tomotake
KEK, Cosmology
2014/06/11, 10/27–10/31

Matsuno, Ken
Osaka City U
2014/11/10–11/14

Matsuo, Shinichiroh
Osaka U, Mathematics
2014/11/06

Matsuura, Shunji
RIKEN, String Theory
2014/11/06

Mattelaer, Olivier
IPPP, Durham U
2015/03/25–03/27

Mawatari, Kentarou
Vrije Universiteit Brussel
2015/03/04–03/06, 03/25–03/27

Mayekar, Sukant Narendra
Tata Inst, High Energy Physics
2014/07/06–07/26, 11/16–12/20, 2015/01/24–03/28

McCauley, Neil
U Liverpool, High Energy Physics
2015/01/28–01/31

McCullough, Matthew
CERN, Particle Theory
2014/10/25–10/28

McFarland, Kevin
U Rochester, High Energy Physics
2015/02/08–02/10

McKinney, Jonathan C
U Maryland, Astrophysics
2014/11/10–11/14

Medina, Anibal
U Melbourne, Particle Theory
2015/02/01–02/07

Mei, Simona
U Paris 7. Denis Diderot
2015/01/31–02/06

Mekareeya, Noppadol
MPI for Physics, String Theory
2015/01/18–01/30

Menard, Brice
Johns Hopkins U, Astrophysics
2014/04/12–04/21, 08/15–08/29

Meneghetti, Massimo
INAF BOLOGNA, Astronomy
2014/11/16–11/22

Menendez, Pablo Fernandez
UAM
2015/01/28–01/31

Milgrom, Mordehai
Weizmann Inst, Cosmology
2014/10/20–11/10

Miller, Adam
CALTECH, Astrophysics
2015/03/26

Minakata, Hisakazu
U Sao Paulo, Neutrino Physics
2015/01/28–01/31

Minamino, Akihiro
Kyoto U, Neutrino Physics
2015/01/28–01/31

Minamitsuji, Masato
U. Lisbon, Cosmology
2014/11/10–11/14

Minasian, Ruben
IPhT, CEA-Saclay, String Theory
2014/04/21–04/25

Mine, Shunichi
UC Irvine, Neutrino Physics
2015/01/28–01/31

Mineshige, Shin
Kyoto U, Astrophysics
2014/04/07–04/11

Mishima, Takashi
Nihon U
2014/11/10–11/13

Misonoh, Yusuke
Waseda U
2014/11/10–11/14

Misumi, Nobuhiko
Osaka U
2014/11/10–11/14

Mitsui, Takahisa
Keio U
2014/11/06

Mitsumatsu, Yoshihiko
Chuo U, Mathematics
2014/04/21–04/24

Miura, Makoto
U Tokyo, ICRR, High Energy Physics
2015/01/28–01/31

Miyadera, Takayuki
Kyoto U
2015/03/04–03/06

Miyamoto, Yuhei
U Tokyo, RESCEU, Cosmology
2014/11/10–11/14

Miyazaki, Akihito
Nagasaki U
2014/11/09–11/13

Mizukami, Kuniyoshi
YNU
2014/04/08, 04/14, 05/23, 06/16, 09/30, 10/27–10/31, 11/11, 11/25, 12/01, 12/09, 12/12, 12/25, 2015/01/17, 01/24

Mizuno, Shuntaro
Waseda U, Cosmology
2014/11/10–11/14

Mizuta, Akira
RIKEN, Astrophysics
2014/11/06

Mohanty, Gagan Bihari
Tata Inst, High Energy Physics
2014/06/16, 11/08–11/10, 2015/02/04–02/06

Mohanty, Subhashree
Tata Inst, High Energy Physics
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Moller, Heiko
TU Darmstadt, Astronomy
2014/11/18–11/28

Mori, Shingo
KEK, Particle Theory
2015/03/27

Mori, Takaharu
RIKEN
2014/11/06

Mori, Toshinori
U Tokyo, ICEPP, High Energy Physics
2015/03/25–03/26

Morikawa, Masahiro
Ochanomizu U, Astrophysics
2014/09/24

Morioka, Masayo
Tohoku U
2014/11/16–11/21

Moritani, Yuki
Hiroshima U, Astronomy
2015/02/25–02/26

Morrison, David R
UC Santa Barbara, Mathematics
2014/06/29–07/01

Motohashi, Hayato
University of Chicago, Cosmology
2014/11/10–11/14

Mujica (Buron), Francisco Forster
U Chile, Astronomy
2014/10/10, 10/16–10/17

Mukohyama, Shinji
Kyoto U, Cosmology
2014/04/02–04/05, 05/29–06/09 ,11/06–11/16, 12/01–12/06, 12/24–12/30

Munir, Shoaib
APCTP, Particle Theory
2015/02/09–02/10

Murata, Keiju
Keio U, Astrophysics
2014/10/28, 11/10–11/13

Murata, Ryoma
UTokyo, Cosmology
2014/11/27–2015/03/31

Murgia, Simona
UC Irvine, Particle Theory
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Nagamine, Kentaro
Osaka U, Astrophysics
2014/04/06–04/11

Nagataki, Shigehiro
RIKEN, Astrophysics
2014/11/06

Nair, Remya
Jamia Millia Islamia
2015/02/23–02/25

Nakagawa, Yuya
U Tokyo, ISSP
2014/11/06

Nakahata, Masayuki
U Tokyo, ICRR, Astroparticle Physics
2015/01/28–01/31

Nakajima, Koki
Hirosaki U
2014/11/09–11/14

Nakama, Tomohiro
U Tokyo, RESCEU
2014/11/10–11/14

Nakamura, Junya
KEK, High Energy Physics
2015/03/25–03/26, 2015/03/27

Nakamura, Katsuro
KEK, High Energy Physics
2014/04/15, 04/22, 05/20, 06/10, 06/16, 07/01, 07/08, 07/15, 07/17, 07/22, 07/25, 07/29, 08/04–08/05, 08/07–08/08, 08/11, 08/13, 08/19, 08/25–08/26, 08/29, 09/01, 09/03–09/04, 09/08, 10/23, 10/28, 10/31, 11/07, 11/14, 2015/01/13, 01/16, 02/13, 02/17

Nakamura, Kouji
NAOJ, Astronomy
2014/11/10–11/14

Nakamura, Shin
Chuo U., Particle Theory
2014/05/20, 11/06, 11/10–11/14, 2015/01/19

Nakanishi, Yukari
Osaka U
2014/11/10–11/14

Nakano, Hiroyuki
Kyoto U, Astrophysics
2014/11/10–11/14

Nakano, Yuuki
U Tokyo, ICRR, Experimental Physics
2015/01/28–01/31

Nakao, Ken-ichi
Osaka City U., Particle Theory
2014/11/10–11/14

Nakao, Mitsutaka
UTokyo
2014/06/24

Nakasato, Naohito
The University of Aizu, Astronomy
2014/07/09–07/10, 09/25–09/26

Nakaya, Tsuyoshi
Kyoto U, High Energy Physics
2015/01/28–01/31

Nakayama, Kazunori
U Tokyo, Cosmology
2014/06/04

Nakayama, Shoei
U Tokyo, ICRR, Neutrino Physics
2015/01/28–01/31

Nakayama, Yu
CALTECH, String Theory
2014/12/18–2015/01/07

Nambu, Yasusada
Nagoya U, KMI
2014/11/11–11/13

Nantais, Corina
U British Columbia
2015/01/28–01/31

Nappi, Chiara
Princeton U
2014/11/19–11/23

Narayan, Ramesh
Harvard U, Astrophysics
2014/04/06–04/12

Narikawa, Tatsuya
Osaka U, Astrophysics
2014/11/10–11/14

Naruko, Atsushi
Tokyo Tech, Cosmology
2014/08/06, 11/10–11/14

Natarajan, Priyamvada
Yale U, Astrophysics
2014/04/06–04/12

Neder, Thomas
U Southanpton, Neutrino Physics
2014/05/07–05/23

Newman, Andrew
Carnegie Observatories
2015/02/01–02/07

Nguyen, Timothy
SCGP, Mathematics
2014/06/12–06/19

Nipoti, Carlo
U. Bologna
2015/02/01–02/06

Nisar, Nellikunnummel
Tata Inst, High Energy Physics
2014/09/17–11/15, 2015/02/11–03/07

Nishi, Sakine
Rikkyo U
2014/11/10–11/14

Nishida, Maya
KEK
2014/04/15

Nishikawa, Ryusuke
Osaka City U
2014/11/09–11/12

Nishima, Wataru
RIKEN
2014/11/06

Nishimichi, Takahiro
IAP, Astronomy
2014/11/24–11/30, 2015/03/04–03/11

Nishimura, Yasuhiro
U Tokyo, ICRR, Neutrino Physics
2014/04/15, 2015/01/28–01/31

Nishino, Yuki
Kyoto U
2014/11/10–11/14

Nishizawa, Atsushi
Nagoya U, Astronomy
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Nitta, Daisuke
Nagoya U
2014/11/10–11/14

Nixon, Chris
U Colorado Boulder, Astrophysics
2014/04/06–04/12

Noda, Sosuke
Nagoya U
2014/11/10–11/14

Nomura, Daisuke
Kyoto U, Particle Theory
2015/03/25–03/27

Nomura, Kouichi
Kyoto U
2014/11/10–11/14

Nori, Franco
RIKEN
2014/11/06

Noumi, Toshifumi
RIKEN, Particle Theory
2014/11/06

Nozaki, Masahiro
Kyoto U, Particle Theory
2014/10/24

Nozaki, Yuta
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Nozawa, Takaya
NAOJ, Astronomy
2014/09/25

Nunokawa, Hiroshi
Pontificia Universidad Catolica de Chile
2015/01/28–01/31

O'Sullivan, Erin
Duke U
2015/01/28–01/31

Oba, Junpei
Nagoya U
2014/10/27–10/31

Obata, Ippei
Kyoto U, Astrophysics
2014/11/10–11/14

Ogasawara, Kota
Rikkyo U
2014/11/10–11/14

Ogawa, Hiromu
Rikkyo U
2014/11/10–11/14

Ohara, Yuichi
Nagoya U
2014/11/10–11/14, 2015/03/04–03/06

Ohashi, Seiju
KEK
2014/11/10–11/14

Ohmura, Takayuki
Hamamatsu Photonics, High Energy Physics
2015/01/28–01/31

Ohnishi, Hiroaki
RIKEN
2014/11/06

Ohnishi, Shota
RIKEN
2014/11/06

Ohsuga, Ken
NAOJ, Astrophysics
2014/04/07–04/11

Ohta, Hiroshi
Nagoya U, Mathematics
2014/04/21–04/24

Ohta, Nobuyoshi
Kinki U, Particle Theory
2014/11/10–11/12

Okabe, Rempei
Keio U
2014/11/06

Okabe, Taizo
U Tokyo
2015/02/20

Okada, Kyoko
SEIKO EG&G, Neutrino Physics
2015/01/28–01/31

Okada, Mariko
RIKEN
2014/11/06

Okada, Nobuchika
KEK
2015/03/25–03/26

Okajima, Yuji
Tokyo Tech, High Energy Physics
2015/01/28–01/31

Okamura, Naotoshi
International University of Health and Welfare, High Energy Physics
2015/03/25–03/27

Okamura, Sadanori
Hosei U, Astronomy
2014/06/30

Okawa, Yuji
U Tokyo, String Theory
2015/03/31

Okazaki, Tadashi
Osaka U, String Theory
2015/02/09–02/12

Okumura, Kimihiro
U Tokyo, ICRR, Neutrino Physics
2015/01/28–01/31

Okura, Yuki
NAOJ, Astronomy
2015/01/19–01/23

Omori, Yuuki
McGill University
2014/08/20–08/21

Ono, Kaoru
Kyoto U, Mathematics
2014/04/20–04/25

Ono, Toshiaki
Hirosaki U
2014/11/09–11/14

Oohara, Ken-ichi
Niigata U., Astrophysics
2014/11/10–11/14

Orellana, Mariana
Universidad Nacional de Rio Negro
2015/02/01–02/28

Orita, Ryuma
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Orlando, Domenico
Ecole normale superieure, String Theory
2014/06/02–06/22, 2015/03/26–04/27

Osato, Ken
U Tokyo, ICRR, Astrophysics
2014/04/07–04/11, 10/27–10/31

Osawa, Mariko
Nichan Co
2014/11/06

Oshita, Naritaka
U Tokyo, RESCEU
2014/10/27–10/31

Ota, Atsuhisa
Tokyo Tech, Astrophysics
2014/10/27–10/31, 11/10–11/14

Ovsiannikova, Tatiana
INR RAS
2015/01/28–01/31

Oyama, Yuichi
KEK, Experimental Physics
2015/01/28–01/31

Pac, Myoung Youl
Dongshin U
2015/01/28–01/31

Paccagnella, Angela
Universita' di Padova, Astronomy
2015/02/10–04/20

Pacif, Shibesh Kumar Jas
Manipal University Jaipur
2014/11/09–11/14

Pacifici, Camila
Yonsei U Observatory, Astrophysics
2015/03/11–03/18

Pagani, Davide
CP3
2015/03/25–03/27

Pain, Reynald
Pierre and Marie Curie U, Astrophysics
2014/10/20–10/23

Pajitnov, Andrei
U Nantes, Mathematics
2014/04/01–06/22

Panpanich, Sirachak
Waseda U
2014/11/10–11/14

Paoloni, Eugenio
INFN-Pisa, High Energy Physics
2014/06/16

Park, Jihun
IBS, POSTECH, Mathematics
2014/04/14–04/19

Park, Myeonghun
APCTP, Particle Theory
2015/02/16

Patel, Nikhul
Kyoto U
2015/01/28–01/31

Patel, Shannon
Carnegie Observatories
2015/02/01–02/07

Payne, David
U Liverpool, Neutrino Physics
2015/01/28–01/31

Peccei, Roberto
UCLA, Particle Theory
2015/03/25–03/26

Peloton, Julien
U Paris 7. Denis Diderot
2014/11/09–11/15

Pen, Ue-Li
CITA, Astrophysics
2014/11/04

Peskin, Michael E
SLAC, Particle Theory
2015/02/18

Petcov, Serguey Todorov
SISSA, Particle Theory
2014/02/20–04/04, 11/13–11/30, 2015/01/22–01/24

Pickering, Luke
Imperial Coll. London
2015/01/28–01/31

Pimenov, Svyatoslav
Yale Univ., Mathematics
2014/09/01–2016/08/31

Plehn, Tilman
Heidelberg U, Particle Theory
2015/03/25–03/27

Poggianti, Bianca
INAF Padova, Astronomy
2015/01/27–02/07

Poletti, Davide
U Paris 7. Denis Diderot
2014/11/09–11/15

Porfyriadis, Achilleas
Harvard U, String Theory
2014/06/06–06/13

Price, Paul
Princeton U, Astrophysics
2014/10/21–10/29

Profeti, Alessandro
INFN-Pisa, High Energy Physics
2014/06/16

Proga, Daniel
U Nevada, Las Vegas, Astrophysics
2014/04/06–04/12

Pruttivarasin, Thaned
RIKEN
2014/11/06

Quilain, Benjamin
Ecole Polytechnique, Neutrino Physics
2015/01/28–01/31

Quimby, Robert Michael
San Diego State University, Astronomy
2014/11/16–11/23, 2015/02/20–02/27

Radicevic, Djordje
Stanford U, String Theory
2014/10/14–10/30

Radicioni, Emilio
INFN Bari
2015/01/28–01/31

Rainwater, David
U Texas
2015/03/25–03/27

Rajbanshi, Umesh Kumar
University of Hyderabad
2014/11/09–11/15

Rangamani, Mukund
Durham U, String Theory
2015/01/08

Rayner, Mark
U Geneva, Neutrino Physics
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Recksiegel, Stefan
TUM
2015/03/25–03/27

Reffert, Susanne
CERN, String Theory
2014/06/02–06/22

Reffert, Susanne
University of Bern, String Theory
2015/03/26–04/27

Regnault, Nicolas
CNRS, Astrophysics
2014/10/19–10/24

Rettura, Alessandro
IPAC, Caltech
2015/02/02–02/06

Reynolds, Christopher Stephen
U Maryland, Astrophysics
2014/04/06–04/12

Rhodes, Jason
NASA JPL/Caltech, Astrophysics
2014/10/27–10/31

Richard, Euan
U Tokyo, ICRR, High Energy Physics
2015/01/28–01/31

Rizzo, Giuliana
INFN-Pisa, High Energy Physics
2014/06/16

Roberts, Matthew
KCTP, Mathematics
2014/04/08

Rondio, Ewa
NCBJ
2015/01/28–01/31

Rosa, Joao
U Aveiro, Cosmology
2015/02/05–02/11

Rose, Joachim
U Liverpool
2015/01/28–01/31

Rosly, Alexey
ITEP, Mathematics
2015/01/15–02/15

Rostworowski, Andrzej
The Sapienza University of Rome
2014/11/09–11/16, 11/10–11/14

Rott, Carsten
Sungkyunkwan U, Astrophysics
2015/01/28–01/31

Ruan, Yongbin
U Michigan, Mathematics
2014/07/23–07/27

Saa, Sara
Instituto de Física Teórica (IFT) UAM-CSIC in Madrid, Spain
2015/03/21–04/05

Sadowski, Aleksander
Harvard U, CfA, Astrophysics
2014/04/07–04/11

Saha, Ipsita
Indian Association for the Cultivation of Science, Particle Theory
2014/05/12–05/26

Saida, Hiromi
Daido U
2014/11/13–11/14

Saijo, Motoyuki
Waseda U
2014/11/10–11/14

Saikawa, Ken'ichi
Tokyo Tech, Particle Theory
2014/10/27–10/31, 11/10–11/14

Saito, Naohito
KEK, High Energy Physics
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Saito, Sho
Nagoya U, Mathematics
2014/11/04–11/05

Saitou, Rio
Kyoto U, Cosmology
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Sakai, Norisuke
Keio U, Particle Theory
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Sakai, Yuji
RIKEN
2014/11/06

Sakaki, Yasuhito
KEK, Theoretical Physics
2014/06/06, 2015/03/25–03/27

Sakakihara, Yuki
Kyoto U, Astrophysics
2014/11/10–11/14

Sakurai, Kazuki
King's College London, Particle Theory
2014/06/12

Sakurai, Yuya
U Tokyo, Astrophysics
2014/04/07–04/11

Sanches, Fabio Henrique Iunes
UC Berkeley
2015/01/05–05/23

Sánchez, Federico
IFAE-Barcelona
2015/03/28–04/11

Sand, Odd Petter
Univ. of Oslo, Astrophysics
2014/07/16, 11/13

Sandon, Sheila
U Strasbourg, Mathematics
2014/04/21–04/24

Sasaki, Junya
U Tokyo
2014/04/01–04/02, 04/08–04/10, 04/14–04/18, 04/21–04/25, 04/28, 05/01, 05/07–05/09, 05/13, 05/16, 05/19–21, 2014/05/23, 05/27–05/29, 06/02–06/03, 06/09–06/12, 06/16–06/17, 06/25–06/26, 06/30, 07/01, 07/03–07/04, 07/07–07/08, 07/14, 07/16–07/17, 07/24, 07/28–07/29, 07/31–08/01, 08/11–08/13, 08/18–08/21, 09/03–09/05, 09/09–09/12, 09/25–09/26, 09/29–09/30, 10/02–10/03, 10/07–10/10, 10/14–10/17, 10/20–10/24, 10/27, 10/29–10/31, 11/07, 11/09–11/14, 11/18–11/21, 11/24–11/25, 11/27–11/28, 12/01–12/05, 12/08–12/11, 12/15, 12/18–12/19, 12/25, 2015/01/09, 01/26–01/27, 02/05, 02/16, 02/18, 02/20, 02/23, 02/27, 03/03–03/06, 03/10–03/11, 03/13, 03/17–03/18, 03/20, 03/25–03/26

Sasaki, Misao
Kyoto U, Cosmology
2014/11/11–11/14

Sasao, Noboru
Okayama U, Particle Theory
2014/10/01

Sato, Kiichiro
Tokyo U of Science
2014/11/09–11/14

Sato, Koichi
RIKEN
2014/11/06

Sato, Nobuhiko
KEK
2014/04/03, 04/07–04/10, 04/14–04/16, 04/18, 04/21, 04/23, 04/25, 04/30–05/01, 05/07–05/09, 05/12–05/14, 05/16, 05/22–05/23, 05/26–05/28, 06/02, 06/05–06/06, 06/10, 06/12–06/13, 06/16, 06/20, 06/23, 06/26, 07/01, 07/03–07/04, 07/07–07/10, 07/14–07/16, 07/22, 07/24, 07/29–07/30, 08/04, 08/06–08/08, 08/19, 08/21, 08/27, 09/03, 09/05, 09/09, 09/16, 09/19, 09/24–09/25, 09/29–10/03, 10/07, 10/14, 10/16–10/17, 10/24, 11/10–11/12, 11/14, 11/17–11/19, 11/26–11/28, 12/01–12/03, 12/05, 12/15, 12/17–12/19, 12/25, 2015/01/07, 01/14, 01/16, 01/19–01/20, 01/26–01/27, 02/02, 02/13, 02/16–02/17, 03/02–03/06, 03/09–03/13, 03/17–03/20, 03/26–03/27, 03/30

Sato, Ryosuke
KEK, Particle Theory
2015/03/25–03/26

Sato, Yuushi
The University of Tokyo, Astronomy
2014/07/09, 10/23

Savelyev, Yakov
ICMAT Madrid, Mathematics
2014/04/21–04/24

Schechtman, Vadim
U Paul Sabatier, Mathematics
2014/10/27–11/04

Schmickler, Christiane
RIKEN
2014/11/06

Schmude, Johannes
Universidad de Oviedo, String Theory
2014/11/17–11/23

Scholberg, Kate
Duke U, Neutrino Physics
2014/11/11–11/17, 12/23–2015/01/06

Scholberg, Kate
Duke U, Neutrino Physics
2014/12/23–2015/01/06

Schramm, Malte
U Tokyo, IPMU, Astronomy
2014/05/01–05/15, 09/19–09/30, 10/14–10/21

Schwanda, Christoph
HEPHY, Austrian Academy of Sciences
2014/11/09–11/11

Scott, Mark
TRIUMF, Neutrino Physics
2015/01/28–01/31, 03/25–03/26

Seino, Yoshiaki
Niigata U
2014/04/13–04/18, 04/21–05/01, 05/12–05/16, 05/18–05/23, 05/26–05/30, 06/01–06/05, 06/08–06/13, 06/16–06/18, 06/23–07/04, 07/06–07/18, 07/22–08/02, 08/06–08/08, 08/11–08/14, 08/17–08/22, 08/24–08/27, 08/28–09/02, 09/05–09/19, 09/23–10/03, 10/05–10/17, 10/19–11/01, 11/06–11/14, 11/17–11/21, 11/25–12/05, 12/08–12/19, 12/24–12/26, 2015/01/15–01/16, 02/16–02/20, 02/23–02/28, 03/02–03/04, 03/09–03/20

Sekiguchi, Atsushi
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Sekiguchi, Tetsuro
KEK, Experimental Physics
2015/01/28–01/31, 03/25–03/26

Sekiya, Hiroyuki
U Tokyo, ICRR, Astroparticle Physics
2015/01/28–01/31

Senami, Masato
Kyoto U
2014/11/06

Senatore, Leonardo
Stanford U, Particle Theory
2014/11/10–11/14

Sendouda, Yuuiti
Hirosaki U, Astrophysics
2014/11/10–11/14

Seng, Gim
McGill University, String Theory
2015/01/04–01/10

Seo, Hee-Jong
Ohio U, Astrophysics
2014/06/10–06/13

Seong, Rak-Kyeong
KIAS, String Theory
2014/10/13–10/17

Seto, Naoki
Kyoto U, Astrophysics
2014/11/11–11/15

Seto, Osamu
Hokkai-Gakuen U, Particle Theory
2014/11/11–11/15

Shaghoulian, Edgar
Stanford U, High Energy Physics
2014/04/19–05/01

Shah, Raj
U Oxford, Neutrino Physics
2015/01/28–01/31

Shamir, Muhammad Farasat
NUCES
2014/11/09–11/15

Shao, Shu-Heng
Harvard U, String Theory
2014/12/15–12/19

Shen, Yefeng
Stanford University, Mathematics
2015/03/10–03/22

Sheth, Ravi
ICTP, Cosmology
2014/04/20–05/02

Shibata, Sanshiro
Konan U, Astrophysics
2014/11/04–11/07

Shibuya, Takatoshi
U Tokyo, ICRR
2015/02/02–02/06

Shimada, Tokuzo
Meiji U, Particle Theory
2014/11/06

Shimakawa, Kazuhisa
Okayama U, Mathematics
2014/04/21–04/24

Shimizu, Hiroyuki
U Tokyo, Particle Theory
2015/03/04–03/06

Shimizu, Itaru
Tohoku U, High Energy Physics
2015/01/28–01/31

Shimizu, Nobuhiro
U Tokyo, High Energy Physics
2014/04/07–04/09, 04/30–05/01 ,05/07–05/08, 10/29–10/31, 11/17–11/18, 11/25–11/26, 12/16–12/17, 2015/02/17–02/18, 02/20, 02/23–02/26, 03/04–03/05, 03/11–03/12, 03/18–03/19, 03/25–03/26

Shimizu, Yasuhiro
Tohoku U, Particle Theory
2015/03/25–03/26

Shinkai, Hisaaki
Osaka Inst. Tech, Astrophysics
2014/11/11–11/14

Shiokawa, Hotaka
Johns Hopkins U, Astrophysics
2014/04/07–04/11

Shiose, Ryo
Nihon U
2014/11/10–11/14

Shiozawa, Masato
U Tokyo, ICRR, High Energy Physics
2015/01/28–01/31

Shirai, Satoshi
DESY, Particle Theory
2014/12/22–12/26, 2015/01/05–01/09

Shiraishi, Maresuke
Universita' di Padova, Astronomy
2014/11/30–12/12

Shiromizu, Tetsuya
Nagoya U, String Theory
2014/11/09–11/14

Shiu, Gary
U Wisconsin, Madison, String Theory
2015/01/28

Shlosman, Isaac
U Kentucky, Astronomy
2014/04/06–04/12

Short, Samantha
QMUL
2015/01/28–01/31

Shu, Hongfei
Tokyo Tech
2015/03/04–03/06

Shu, Shibo
NAOJ, Astronomy
2014/10/27–10/31

Singh, Jasbir
Panjab Univ., High Energy Physics
2014/06/16

Smith, Nigel
TRIUMF, High Energy Physics
2014/06/29–07/01

Sobel, Henry W
UC Irvine, Astroparticle Physics
2014/08/20–08/29, 11/11–11/16, 2015/01/28–01/31

Soda, Jiro
Kobe U, Cosmology
2014/11/10–11/14

Sogabe, Noriyuki
Keio U
2014/11/06

Sonnenfeld, Alessandro
UC Santa Barbara, Astrophysics
2015/02/01–02/09

Sorokina, Elena
Sternberg Astro. Inst., Astrophysics
2014/05/31–06/13, 2015/02/02–02/15

Stawarz, Lukasz
JAXA, Astrophysics
2014/04/07–04/11

Stelzer, Tim
University of Illinois
2015/03/25–03/27

Stewart, Trevor
Rutherford Appleton Lab
2015/01/28–01/31

Stoll, Martin
U Tokyo, Particle Theory
2015/03/25–03/26

Stone, James L.
Boston U, High Energy Physics
2014/08/26–09/01

Stone, James M
Princeton U, Astrophysics
2014/04/06–04/12

Stratmann, Marco
U Tuebingen
2015/03/25–03/27

Suda, Takuma
NAOJ, Astronomy
2014/04/21, 05/09

Suda, Yusuke
U Tokyo, High Energy Physics
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Suehara, Taikan
Kyushu U, Particle Theory
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Suenobu, Hiroshi
Nagoya U
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Sugimoto, Shigeki
Kyoto U, String Theory
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Sugimoto, Yoshihiro
Kyoto U, Mathematics
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Sugita, Yuji
RIKEN
2014/11/06

Sugiyama, Naonori
Hiroshima University, Astronomy
2014/10/27–10/31

Sugiyama, Naoshi
Nagoya U, Cosmology
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Sugiyama, Satoshi
U Tokyo, Math Sci, Mathematics
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Sumino, Yukinari
Tohoku U
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Sumitomo, Yosuke
KEK, Particle Theory
2014/11/10–11/14

Sun, Ai-Lei
Princeton U, Astronomy
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Sunyaev, Rashid
Max Plank Institute for Astrophysics, Garching, Astrophysics
2014/12/08–12/13

Suresh, Jishnu
Cochin U
2014/11/09–11/15

Suyama, Teruaki
U Tokyo, RESCEU, Cosmology
2014/11/10–11/14

Suzuki, Motoo
U Tokyo, Particle Theory
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Suzuki, Ryotaku
Osaka City U
2014/11/12–11/14

Suzuki, Tomoharu
Chubu University, Astronomy
2015/02/25, 03/06

Suzuki, Tomohito
Hirosaki U
2014/11/09–11/14

Suzuki, Toshio
Nihon U
2014/11/21–11/22

Tachikawa, Masashi
RIKEN
2014/11/06

Tada, Tsukasa
RIKEN
2014/11/06, 2015/03/04–03/06

Tagoshi, Hideyuki
Osaka U, Astrophysics
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Tait, Tim
UC Irvine, Particle Theory
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Takaesu, Yoshitaro
KEK, Particle Theory
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Takahashi, Fuminobu
Tohoku U, Particle Theory
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Takahashi, Hirotaka
Nagaoka University of Technology
2014/11/09–11/12

Takahashi, Kazufumi
U Tokyo, RESCEU, Astrophysics
2014/11/10–11/14

Takahashi, Masaaki
Aichi University of Education
2014/11/11–11/13

Takahashi, Tomo
Saga U, Cosmology
2014/11/10–11/14

Takakura, Satoru
Osaka U
2014/08/29, 10/27–10/31

Takami, Kentaro
Goethe University Frankfurt
2014/11/09–11/15

Takato, Naruhisa
NAOJ, Hawaii, Astronomy
2014/05/30

Takeda, Naoyuki
U Tokyo, ICRR, Astrophysics
2014/11/10–11/14

Taketa, Akimichi
U Tokyo, High Energy Physics
2015/01/28–01/31

Takeuchi, Michihisa
King's College London, Particle Theory
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Takeuchi, Yasuo
Kobe U, Astroparticle Physics
2015/01/28–01/31

Taki, Masato
RIKEN
2014/11/06

Tanabashi, Masaharu
Nagoya U
2015/03/25–03/26

Tanabe, Kotaro
KEK
2014/11/10–11/14

Tanabe, Tomohiko
U Tokyo, ICEPP, Particle Theory
2014/10/29

Tanaka, Hide-Kazu
U Tokyo, ICRR, Neutrino Physics
2015/01/28–01/31

Tanaka, Hirohisa
U British Columbia, Neutrino Physics
2015/01/28–01/31

Tanaka, Kazuhiro
Juntendo University
2015/03/25–03/26

Tanaka, Masaomi
NAOJ, Astronomy
2014/09/25

Tanaka, Minoru
Osaka U
2015/03/25–03/26

Tanaka, Takahiro
Kyoto U, Cosmology
2014/11/10–11/14

Tanaka, Yasuo
MPI for Extraterrestrial Physics, Astrophysics
2014/06/16–06/17, 10/21–10/23

Tanaka, Yuichiro
U Tokyo, Math Sci, Mathematics
2014/11/07–12/12

Tange, Motoo
U Tsukuba, Mathematics
2014/04/21–04/24

Taniguchi, Keisuke
U Tokyo
2014/11/10–11/14

Tanikawa, Ataru
RIKEN, Astrophysics
2014/10/23

Taruya, Atsushi
Kyoto U, Astrophysics
2014/11/10–11/12

Tashiro, Hiroyuki
Nagoya U, Cosmology
2014/10/28–10/31

Tata, Xerxes
U Hawaii
2015/03/25–03/27

Terada, Takahiro
U Tokyo, Particle Theory
2015/03/04–03/06

Teraki, Yuto
RIKEN, Astrophysics
2014/11/06

Terukina, Ayumu
Hiroshima U, Astrophysics
2014/11/09–11/14

Teschner, Joerg
DESY, String Theory
2015/01/12–01/15

Teubner, Thomas
U Liverpool
2015/03/25–03/27

Thalmeier, Richard
HEPHY, Austrian Academy of Sciences, High Energy Physics
2014/10/30–11/01, 11/07–11/11

Thanh, Phuc Nguyen
RIKEN
2014/11/06

Tobayama, Shimpei
UBC
2015/01/28–01/31

Tobe, Kazuhiro
Nagoya U, Particle Theory
2015/03/18, 03/25–03/26

Tobioka, Kohsaku
KEK, Particle Theory
2015/03/25–03/27

Toki, Hiroshi
Osaka U
2014/11/21–11/22

Toma, Takashi
LPT Orsay
2015/03/25–03/26

Tomida, Kengo
Princeton U, Astrophysics
2014/04/07–04/11

Tomikawa, Yoshimune
Nagoya U
2014/11/09–11/15

Tominaga, Nozomu
Konan U, Astrophysics
2014/05/07, 05/21, 08/20

Tomizawa, Shinya
Tokyo U of Technology
2014/11/10–11/14

Tonegawa, Motonari
U Tokyo, Astronomy
2014/10/27–10/31

Torii, Shingo
RIKEN, Particle Theory
2014/11/06

Torii, Takashi
Osaka Institute of Tech, Particle Theory
2014/11/10–11/12

Tornow, Werner
Duke U, Neutrino Physics
2015/01/18–01/28

Traktenbrot, Benny
ETH Zurich, Astronomy
2014/10/14–10/22

Tram, Thomas
U Portsmouth, Cosmology
2014/10/27–10/31

Treu, Tommaso
UCLA, Astrophysics
2014/11/17–11/21

Trimm, Anderson Daniel
U Texas, String Theory
2014/06/17–08/19

Trujillo, Ignacio
Instituto de Astrofisica de Canarias
2015/02/01–02/10

Tsuboi, Takashi
U Tokyo, Math Sci, Mathematics
2014/04/21

Tsuboyama, Toru
KEK, High Energy Physics
2014/04/07, 05/27, 06/06, 06/10, 06/16, 06/30, 07/08, 07/10, 07/21, 08/02, 08/05, 08/19, 08/27, 09/01, 09/04, 09/09, 10/21, 11/07, 2015/03/19

Tsuchiya, Takuya
Waseda U
2014/11/11–11/14

Tsujikawa, Shinji
Tokyo U of Science, Cosmology
2014/11/10–11/14

Tsukamoto, Naoki
Fundan U
2014/11/09–11/14

Tsuruta, Sachiko
Montana State U, Astrophysics
2014/05/30–06/17, 12/12, 12/22–12/29, 2015/01/05–01/07

Turner, Edwin L
Princeton U, Astrophysics
2014/05/28–06/19, 09/04–11/01, 2015/02/05–03/05

Turner, Jessica
Instituto de Física Teórica (IFT) UAM-CSIC in Madrid, Spain, Theoretical Physics
2015/03/21–04/04

Uchida, Yoshi
Imperial Coll. London
2015/01/28–01/31

Uchikata, Nami
CENTRA / IST
2014/11/10–11/14

Uchiyama, Fumiyo
, Particle Theory
2014/11/06, 11/10–11/14

Uehara, Hokuto
Tokyo Metropolitan U, Mathematics
2014/10/06–10/07, 10/14, 10/20–10/21, 10/27–10/28, 12/01–12/02, 12/08–12/09, 2015/01/19–01/20, 02/09–02/10, 03/09–03/10, 03/23–03/24, 03/30–03/31

Uozumi, Satoru
Kyungpook National U, High Energy Physics
2014/06/30–08/31, 2015/01/05–02/13

Upadhye, Amol
IEU, Astronomy
2014/07/14–07/19

Urakawa, Ryosuke
Waseda U
2014/11/10–11/14

Urakawa, Yuko
Nagoya U, Cosmology
2014/11/10–11/14

Uriu, Koichiro
RIKEN
2014/11/06

Ushiroda, Yutaka
KEK, High Energy Physics
2014/07/22

Valls-Gabaud, David
CNRS, Astrophysics
2014/10/23

Van Der Wel, Arjen
MPI for Astronomy
2015/01/30–02/07

van Garrel, Michel
KIAS, Mathematics
2014/05/13–05/18

van Koert, Otto
Seoul Natl U, Mathematics
2014/04/21–04/24

Vegetti, Simona
MPI for Astrophysics, Astrophysics
2014/11/16–11/22

Vika, Marina
National Observatory of Athens
2015/02/01–02/08

Vilela, Cristovao
SUNY, Stony Brook
2015/03/25–03/26

Vo, Jonathan
IFAE-Barcelona, Experimental Physics
2015/03/12–05/17

Volonteri, Marta
Institut d'Astrophysique de Paris, Astrophysics
2014/04/06–04/13

Volpi, Matteo
IFAE-Barcelona
2014/06/16, 10/31–11/02, 11/07–11/11

Voronov, Alexander
U Minnesota, Mathematics
2014/12/27–2015/01/20

Vryonidou, Eleni
U Louvain
2015/03/25–03/27

Wacker, Jay G
SLAC, High Energy Physics
2014/03/27–04/02

Wagner, Alexander
U Tsukuba, Astrophysics
2014/04/07–04/11

Wakabayashi, Yasuhiro
Kyoto U, Mathematics
2015/01/16

Wakamatsu, Takashi
Niigata U
2014/11/11–11/14

Wake, David
U Wisconsin, Madison, Astronomy
2015/01/31–02/07

Wall, Aron
RIKEN, High Energy Physics
2014/11/06

Walter, Christopher W
Duke U, Neutrino Physics
2014/06/23–07/06, 11/09–11/16, 2015/01/28–01/31

Wanajo, Shinya
RIKEN, Astronomy
2014/11/06

Wark, David L
Rutherford Appleton Lab., Neutrino Physics
2015/01/28–01/31

Watanabe, Haruki
U Tokyo, Condensed Matter Physics
2014/07/01

Watanabe, Jun
U Tokyo, Math Sci, Mathematics
2014/04/21–04/24

Watanabe, Kazuyoshi
Kyoto U, Mathematics
2014/04/21–04/24

Watanabe, Tadayuki
Shimane U, Mathematics
2014/04/21–04/24

Watanabe, Yuki
U Tokyo, RESCEU, Cosmology
2014/10/27–10/31, 11/10–11/14

Webber, Bryan
U Cambridge, Particle Theory
2014/02/17–05/16

Weinberg, Sean Jason
UC Berkeley
2015/02/01–05/26

Wendell, Roger Alexandre
U Tokyo, ICRR, Neutrino Physics
2014/04/15, 2015/01/28–01/31

White, Jonathan
U Tokyo, RESCEU
2014/11/10–11/14

Wilking, Michael
SUNY, Stony Brook, Neutrino Physics
2015/01/28–01/31, 03/25–03/26

Williams, Harold
U Texas, Mathematics
2014/09/15–09/16

Witten, Edward
IAS, String Theory
2014/11/19–11/23

Wolfson, Jesse
Northwestern U, Mathematics
2013/09/06–2014/09/05, 12/16–12/19

Wong, Kenny
U Cambridge, String Theory
2015/01/15–04/15

Wongwathanarat, Annop
RIKEN, Astrophysics
2014/11/06

Wrase, Timm
Stanford U, Theoretical Physics
2014/08/03–08/09

Xu, Chenyuan
Okayama U
2015/01/28–01/31

Yabe, Kiyoto
NAOJ, Astronomy
2015/02/25–02/26

Yagi, Junya
SISSA, Particle Theory
2014/07/08–07/09

Yagi, Yoshimune
Kyoto U, Mathematics
2014/04/21–04/24

Yajima, Hidenobu
U Edinburgh, Astronomy
2014/04/06–04/11

Yajima, Kohji
Rikkyo U
2014/10/27–10/31, 11/10–11/14

Yamada, Kei
Hirosaki U
2014/11/09–11/15

Yamada, Masaki
U Tokyo, ICRR, Cosmology
2014/11/10–11/14, 2015/03/04–03/06

Yamada, Toshifumi
KEK, Particle Theory
2015/03/27

Yamada, Youichi
Tohoku U
2015/03/25–03/26

Yamaguchi, Masahide
Tokyo Tech, Cosmology
2014/11/10–11/14

Yamaguchi, Yasuhiro
RIKEN
2014/11/06

Yamamoto, Naoki
Keio U
2014/11/06

Yamanaka, Masashi
KEK, High Energy Physics
2014/05/08

Yamanaka, Masato
Nagoya U, Particle Theory
2015/03/25–03/26

Yamanaka, Nodoka
RIKEN
2014/11/06

Yamashita, Kimiko
Ochanomizu U
2015/03/25–03/27

Yamashita, Tetsu
YNU
2014/09/30, 10/27–10/31, 11/11, 11/25, 12/01, 12/09, 12/16, 12/25, 2015/01/16

Yamashita, Yasuho
Kyoto U, Cosmology
2014/11/10–11/14

Yamauchi, Daisuke
U Tokyo, RESCEU, Cosmology
2014/11/10–11/14

Yan, Qi-Shu
Chinese Academy of Sciences
2015/03/25–03/27

Yang, Jinwei
Rutgers U, Piscataway, Mathematics
2014/08/11–08/14

Yano, Takatomi
Kobe U, Neutrino Physics
2015/01/28–01/31

Yazaki, Koichi
RIKEN
2014/11/06

Yen, Stanley
TRIUMF
2015/01/28–01/31

Yin, Xi
Harvard U, String Theory
2015/01/20

Yokoya, Hiroshi
U Toyama, Particle Theory
2015/03/25–03/27

Yokoyama, Jun'ichi
U Tokyo, RESCEU, Astrophysics
2014/11/10–11/14

Yokoyama, Masashi
U Tokyo, High Energy Physics
2014/04/15, 2015/01/28–01/31

Yokoyama, Shuichiro
Rikkyo U, Cosmology
2014/11/10–11/14

Yokozawa, Takaaki
Osaka City U., Experimental Physics
2014/04/15

Yoneda, Gen
Waseda U
2014/11/10–11/14

Yonehara, Takehiro
U Tokyo
2014/11/06

Yoo, Chulmoon
Nagoya U, Cosmology
2014/11/09–11/14

Yoshida, Daisuke
Tokyo Tech, Cosmology
2014/11/10–11/14

Yoshida, Shigeru
Chiba U, Neutrino Physics
2014/11/10–11/14

Yoshida, Shin'ichiro
U Tokyo
2014/11/11–11/14

Yoshida, Tomoyo
Tokyo Tech
2015/01/28–01/31, 03/25–03/26

Yoshida, Yutaka
KIAS, String Theory
2014/08/31–09/05

Yoshimura, Motohiko
Okayama U, Particle Theory
2014/10/01

Yoshino, Hirotaka
KEK, Particle Theory
2014/11/10–11/14

Yoshinobu, Toshiki
Tokyo U of Science, High Energy Physics
2014/05/27, 06/02, 07/16, 07/22, 07/29, 08/01, 08/04–08/05, 08/18–08/20, 08/22, 09/02, 09/04, 09/08–09/10, 09/12, 09/16, 09/18, 09/29–10/01, 10/06–10/07, 10/14–10/15, 10/24, 10/27–10/28, 11/10–11/11, 11/14, 11/17–11/18, 11/25–11/26, 12/02, 12/15–12/19, 12/22, 2015/01/07, 01/09, 01/19, 01/21–01/23, 01/26–01/29, 02/05, 02/13, 02/16–02/17, 02/20, 02/23–02/25, 03/03–03/06, 03/09–03/13, 03/16–03/20, 03/25–03/27

Yuan, Qiang
Chinese Academy of Sciences, Astrophysics
2014/08/02–08/17

Yudin, Andrey
ITEP
2014/11/06

Zaldarriaga, Matias
IAS, Astrophysics
2014/06/09–06/13

Zalipska, Joanna
National Centre for Nuclear Research
2015/01/28–01/31

Zeppenfeld, Dieter
KIT
2015/03/25–03/26

Zhang, Yi
CUHK, Mathematics
2014/07/06–07/13

Zhu, Ruidong
U Tokyo
2015/03/04–03/06

Ziembicki, Marcin
Warsaw University of Technology
2015/01/28–01/31, 03/25–03/26

Zimmerman, Eric D
U Colorado Boulder
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Zoupanos, George
NTUA, Particle Theory
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4. Elliptic inflation: interpolating from natural inflation to R^2-inflation
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12. Search for $B^+ \to e^+ \nu_e$ and $B^+ \to \mu^+ \nu_\mu$ decays using hadronic tagging
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15. Search for short baseline ν_e disappearance with the T2K near detector
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Phys. Rev. D **90**, 083520 (2014), date of acceptance 2014.10.08, arXiv:1407.5453 [astro-ph]

IPMU14-0313
Resolving the Clumpy Structure of the Outflow Winds in the Gravitationally Lensed Quasar SDSS J1029+2623
Toru Misawa, Naohisa Inada, Masamune Oguri, Poshak Gandhi, Takashi Horiuchi, Suzuka Koyamada, Rina Okamoto
Astrophys. J. **794**, L20 (2014), date of acceptance 2014.09.19, arXiv:1410.0791 [astro-ph]

IPMU14-0314
Hubble Frontier Fields First Complete Cluster Data: Faint Galaxies at z~5-10 for UV Luminosity Functions and Cosmic Reionization
Masafumi Ishigaki, Ryota Kawamata, Masami Ouchi, Masamune Oguri, Kazuhiro Shimasaku, Yoshiaki Ono
Astrophys. J. **799**, 12 (2015), arXiv:1408.6903 [astro-ph]

IPMU14-0315
The Sizes of z~6-8 Lensed Galaxies from the Hubble Frontier Fields Abell 2744 Data
Ryota Kawamata, Masafumi Ishigaki, Kazuhiro Shimasaku, Masamune Oguri, Masami Ouchi
Astrophys. J. **804**, 103 (2015), arXiv:1410.1535 [astro-ph]

IPMU14-0316
Inferring Host Dark Matter Halo Masses of Individual Galaxies from Neighboring Galaxy Counts
Masamune Oguri, Yen-Ting Lin
Astrophys. J. **801**, 94 (2015), arXiv:1410.0714 [astro-ph]

IPMU14-0317
Universal Asymptotic Eigenvalue Distribution of Large N Random Matrices --- A Direct Diagrammatic Proof to Marchenko-Pastur Law ---
Xiaochuan Lu, Hitoshi Murayama
arXiv:1410.3503 [hep-th]

IPMU14-0318
The f(R) gravity function of the Linde quintessence
S.V.Ketov, N. Watanabe
Phys. Lett. B **741**, 242-245 (2015), date of acceptance 2014.12.12, arXiv:1410.3557 [hep-th]

IPMU14-0319
Dynamical D-Terms in Supergravity
V. Domcke, K. Schmitz, T. T. Yanagida
Nucl. Phys. B **891**, 230-258 (2015), arXiv:1410.4641 [hep-th]

IPMU14-0320
Higgsino Dark Matter in High-Scale Supersymmetry
Natsumi Nagata, Satoshi Shirai
JHEP **01** (2015) 29, date of acceptance 2014.12.20, arXiv:1410.4549 [hep-ph]

IPMU14-0321
Issues in Complex Structure Moduli Inflation
Hirotaka Hayashi, Ryo Matsuda, Taizan Watari
arXiv:1410.7522 [hep-th]

IPMU14-0322
Holographic Interpolation between a and F
Teruhiko Kawano, Yuki Nakaguchi, Tatsuma Nishioka
JHEP **12** (2014) 161, date of acceptance 2014.12.11, arXiv:1410.5973 [hep-th]

IPMU14-0323
Peculiar velocities in redshift space: formalism, N-body simulations and perturbation theory
Teppei Okumura, Uros Seljak, Zvonimir Vlah, Vincent Desjacques
JCAP **05** (2014) 3, date of acceptance 2014.04.03, arXiv:1312.4214 [astro-ph]

IPMU14-0324
Cosmological Tests using Redshift Space Clustering in BOSS DR11
Yong-Seon Song, Cristiano G. Sabiu, Teppei Okumura, Minji Oh, Eric V. Linder
JCAP **12** (2014) 5, arXiv:1407.2257 [astro-ph]

IPMU14-0325
Mass-deformed T_N as a linear quiver
H. Hayashi, Y. Tachikawa, K. Yonekura
JHEP **02** (2015) 089, arXiv:1410.6868 [hep-th]

IPMU14-0326
Lower bound of the tensor-to-scalar ratio r > 0.1 in a nearly quadratic chaotic inflation model in supergravity
Keisuke Harigaya, Masahiro Kawasaki, Tsutomu T. Yanagida
Phys.Lett. B **741**, 267-271 (2015), arXiv:1410.7163 [hep-ph]

IPMU14-0327
Around the uniform rationality
Ilya Karzhemanov

IPMU14-0328
The Newman-Penrose formalism for Riemannian 3-manifolds
Amir Babak Aazami
arXiv:1410.7216 [math]

IPMU14-0329
Penrose's singularity theorem in a Finsler spacetime
Amir Babak Aazami, Miguel Angel Javaloyes
arXiv:1410.7595 [math]

IPMU14-0330
Invisible dark gauge boson search in top decays using a kinematic method
Doojin Kim, Hye-Sung Lee, Myeonghun Park
JHEP **03** (2015) 134, arXiv:1411.0668 [hep-ph]

IPMU14-0331
Determining the Dirac CP Violation Phase in the Neutrino Mixing Matrix from Sum Rules
I. Girardi, S. T. Petcov, A. Titov
Nucl. Phys. B **894**, 733-768 (2015), arXiv:1410.8056 [hep-ph]

IPMU14-0332
Electroweakly-Interacting Dirac Dark Matter
Natsumi Nagata, Satoshi Shirai
Phys. Rev. D **91**, 055035 (2015), date of acceptance 2015.03.30, arXiv:1411.0752 [hep-ph]

IPMU14-0333
Improving the sensitivity of stop searches with on-shell constrained invariant mass variables
Won Sang Cho, James S. Gainer, Doojin Kim, Konstantin T. Matchev, Filip Moortgat, Luc Pape, Myeonghun Park
JHEP **05** (2015) 040, arXiv:1411.0664 [hep-ph]

IPMU14-0334
Resonant conversions of QCD axions into hidden axions and suppressed isocurvature perturbations
Naoya Kitajima, Fuminobu Takahashi
JCAP **01** (2015) 32, arXiv:1411.2011 [hep-ph]

IPMU14-0335
Chaotic Inflation from Nonlinear Sigma Models in Supergravity
Simeon Hellerman, John Kehayias, Tsutomu T. Yanagida
Phys. Lett. B **742**, 390-393 (2015), arXiv:1411.3720 [hep-ph]

IPMU14-0336
Observational properties of low-redshift pair instability supernovae
A. Kozyreva, S.Blinnikov, N.Langer, S.-C. Yoon
A&A **565**, A70 (2014), date of acceptance 2014.03.20, arXiv:1403.5212 [astro-ph]

IPMU14-0337
Non-abelian Dark Matter Solutions for Galactic Gamma-ray Excess and Perseus 3.5 keV X-ray Line
Kingman Cheung, Wei-Chih Huang, Yue-Lin Sming Tsai
JCAP **05** (2015) 53, date of acceptance 2015.05.15, arXiv:1411.2619 [hep-ph]

IPMU14-0338
Antimatter and antistars in the universe and in the Galaxy
S.I. Blinnikov, A.D. Dolgov, K. A. Postnov
Phys. Rev. D **92**, 023516 (2015), arXiv:1409.5736 [astro-ph]

IPMU14-0339
The BV formalism for L_\infty-algebras
Denis Bashkirov, Alexander A. Voronov
arXiv:1410.6432 [math]

IPMU14-0340
Can a spectator scalar field enhance inflationary tensor mode?
Tomohiro Fujita, Jun'ichi Yokoyama, Shuichiro Yokoyama
Prog. Theor. Exp. Phys. **2015**, 043E01 (2015), arXiv:1411.3658 [astro-ph]

IPMU14-0341
Does asymmetric dark matter always lead to an anti-neutrino signal?
Hajime Fukuda, Shigeki Matsumoto, Satyanarayan Mukhopadhyay
Phys. Rev. D **92**, 013008 (2015), arXiv:1411.4014 [hep-ph]

IPMU14-0342
Perverse Schobers
M. Kapranov, V. Schechtman
arXiv:1411.2772 [math]

IPMU14-0343
Coupling Unification and Dark Matter in a Standard Model Extension with Adjoint Majorana Fermions
Tasuku Aizawa, Masahiro Ibe, Kunio Kaneta
Phys. Rev. D **91**, 075012 (2015), arXiv:1411.6044 [hep-ph]

IPMU14-0344
Dark Matter in Split SUSY with Intermediate Higgses
Kingman Cheung, Ran Huo, Jae Sik Lee, Yue-Lin Sming Tsai
JHEP **04** (2015) 151, date of acceptance 2015.04.27, arXiv:1411.7329 [hep-ph]

IPMU14-0345
Radiative Emission of Neutrino Pairs in Atoms and Light Sterile Neutrinos
D.N. Dinh S. T. Petcov
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IPMU14-0346
The Relic Neutralino Surface at a 100 TeV collider
Joseph Bramante, Patrick Fox, Adam Martin, Bryan Ostdiek, Tilman Plehn, Torben Schell, Michihisa Takeuchi
Phys. Rev. D **91**, 054015 (2015), date of acceptance 2015.03.11, arXiv:1412.4789 [hep-ph]

IPMU14-0347
The Pfaffian-Grassmannian equivalence revisited
Nicolas Addington, Will Donovan, Ed Segal
Alg. Geom. (Found. Compos. Math.), date of acceptance **2014**.11.24, arXiv:1401.3661 [math]

IPMU14-0348
Axion dark matter from topological defects
Masahiro Kawasaki, Ken'ichi Saikawa, Toyokazu Sekiguchi
Phys. Rev. D **91**, 65014 (2015), arXiv:1412.0789 [hep-ph]

IPMU14-0349
Tomography from Entanglement
Jennifer Lin, Matilde, Marcolli, Hirosi Ooguri,, Bogdan Stoica
Phys. Rev. Lett. **114**, 221601 (2015), arXiv:1412.1879 [hep-th]

IPMU14-0350
Magnetic discrete gauge field in the confining vacua and the supersymmetric index
Y. Tachikawa
JHEP **03** (2015) 035, arXiv:1412.2830 [hep-th]

IPMU14-0351
Structure formation in a mixed dark matter model with decaying sterile neutrino: the 3.5 keV X-ray line and the Galactic substructure
Akira Harada, Ayuki Kamada, Naoki Yoshida
arXiv:1412.1592 [astro-ph]

IPMU14-0352
Leptogenesis via axion oscillations after inflation
Alexander Kusenko, Kai Schmitz, Tsutomu T. Yanagida
Phys. Rev. Lett. **115**, 011302 (2015), arXiv:1412.2043 [hep-ph]

IPMU14-0353
How to use the Standard Model effective field theory
Brian Henning, Xiaochuan Lu, Hitoshi Murayama
arXiv:1412.1837 [hep-ph]

IPMU14-0354
r_\infty-Matrices, triangular L_\infty-bialgebras, and quantum_\infty groups
Denis Bashkirov, Alexander A. Voronov
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IPMU14-0355
The cosmic growth of the active black hole population at 1<z<2 in zCOSMOS, VVDS and SDSS
A. Schulze, A. Bongiorno, I. Gavignaud, M. Schramm, J. Silverman, A. Merloni, G. Zamorani, M. Hirschmann, V. Mainieri, L. Wisotzki, F. Shankar, F. Fiore, A. M. Koekemoer, G. Temporin
Mon. Not. Roy. Astron. Soc. **447**, 2085-2111 (2015), date of acceptance 2014.11.28, arXiv:1412.0754 [astro-ph]

IPMU14-0356
Degenerate spectrum in the neutrino mass anarchy with Wishart matrices and implications for 0νββ and δCP
Kwang Sik Jeong, Naoya Kitajima, Fuminobu Takahashi
Phys. Rev. D **91**, 113010 (2015), arXiv:1412.4061 [hep-ph]

IPMU14-0357
Anisotropic CMB distortions from non-Gaussian isocurvature perturbations
Atsuhisa Ota, Toyokazu Sekiguchi, Yuichiro Tada, Shuichiro Yokoyama
JCAP **03** (2015) 13, arXiv:1412.4517 [astro-ph]

IPMU14-0358
Notes on Entanglement Entropy in String Theory
Song He, Tokiro Numasawa, Tadashi Takayanagi, Kento Watanabe
JHEP **05** (2015) 106, arXiv:1412.5606 [hep-th]

IPMU14-0359
Entanglement density and gravitational thermodynamics
Jyotirmoy Bhattacharya, Veronika E. Hubeny, Mukund Rangamani, Tadashi Takayanagi
Phys. Rev. D **91**, 106009 (2015), arXiv:1412.5472 [hep-th]

IPMU14-0360
Boundary States as Holographic Duals of Trivial Spacetimes
Masamichi Miyaji, Shinsei Ryu, Tadashi Takayanagi, Xueda Wen
JHEP **05** (2015) 152, arXiv:1412.6226 [hep-th]

IPMU14-0361
Physics at the e+ e- Linear Collider
G. Moortgat-Picka, Shigeki Matsumoto, et.al.
Eur. Phys. J. C**75**, 371 (2015), arXiv:1504.01726 [hep-ph]

IPMU14-0362
Quantum Dilogarithm Identities at Root of Unity
Ivan Ip, Masahito Yamazaki
arXiv:1412.5777 [math]

IPMU14-0363
Entanglement Entropy of Annulus in Three Dimensions
Yuki Nakaguchi, Tatsuma Nishioka
JHEP **04** (2015) 72, date of acceptance 2015.03.23, arXiv:1501.01293 [hep-th]

IPMU14-0364
Holographic Entanglement and Causal Shadow in Time-Dependent Janus Black Hole
Yuki Nakaguchi, Noriaki Ogawa, Tomonori Ugajin
JHEP **07** (2015) 080, date of acceptance 2015.07.15, arXiv:1412.8600 [hep-th]

IPMU14-0365
Two-dimensional superconfomal eld theories from Riemann surfaces with boundary
Koichi Nagasaki, Satoshi Yamaguchi
Phys. Rev. D **91**, 065025 (2015), arXiv:1412.8302 [hep-th]

IPMU14-0366
On the cut-and-paste property of algebraic varieties
Ilya Karzhemanov
arXiv:1411.6084 [math]

IPMU15-0001
Symmetry breaking for representations of rank one orthogonal groups
Toshiyuki Kobayashi, Birgit Speh
Mem. Ame. Math. Soc. **238**, 1126 (2015), date of acceptance 2014.07.18, arXiv:1310.3213 [astro-ph]

IPMU15-0002
Instanton operators and symmetry enhancement in 5d supersymmetric gauge theories
Yuji Tachikawa
Prog. Theor. Exp. Phys. **2015**, 043B06 (2015), arXiv:1501.01031 [hep-th]

IPMU15-0003
Elliptic Inflation: Interpolating from natural inflation to R2-inflation
Tetsutaro Higaki, Fuminobu Takahashi
JHEP **03** (2015) 129, arXiv:1501.02354 [hep-ph]

IPMU15-0004
Cosmology in bimetric theory with an effective composite coupling to matter
A. Emir Gumrukcuoglu, Lavinia Heisenberg, Shinji Mukohyama, Norihiro Tanahashi
JCAP **04** (2015) 8, arXiv:1501.02790 [hep-th]

IPMU15-0005
Postinflationary Higgs relaxation and the origin of matter-antimatter asymmetry
Alexander Kusenko, Lauren Pearce, Louis Yang
Phys. Rev. Lett. **114**, 061302 (2015), date of acceptance 2015.02.11, arXiv:1410.0722 [hep-ph]

IPMU15-0006
The Eynard--Orantin recursion for simple singularities
Todor Milanov
arXiv:1501.03677 [math]

IPMU15-0007
The modular group for the total ancestor potential of Fermat simple elliptic singularities
Todor Milanov, Yefeng Shen
Commun. Num. Theor. Phys. **8**, 329-368 (2014), date of acceptance 2014.01.09, arXiv:1401.2725 [hep-th]

IPMU15-0008
Associated jet and subjet rates in light-quark and gluon jet discrimination
Biplob Bhattacherjee, Satyanarayan Mukhopadhyay, Mihoko M. Nojiri, Yasuhito Sakaki, Bryan R. Webber
JHEP **04** (2015) 131, arXiv:1501.04794 [hep-ph]

IPMU15-0009
Supersymmetric Higgs-portal and X-ray lines
Hyun Min Lee, Chan Beom Park, Myeonghun Park
Phys.Lett. B **744**, 218-224 (2015), arXiv:1501.05479 [hep-ph]

IPMU15-0010
Higgs mass 125 GeV and g-2 of the muon in Gaugino Mediation Model
Keisuke Harigaya, Tsutomu T. Yanagida, Norimi Yokozaki
Phys. Rev. D **91**, 075010 (2015), arXiv:1505.02119 [hep-ph]

IPMU15-0011
SU(5) Grand Unification in Pure Gravity Mediation
Jason L. Evans, Natsumi Nagata, Keith A. Olive
Phys. Rev. D **91**, 055027 (2015), date of acceptance 2015.03.25, arXiv:1502.00034 [hep-ph]

IPMU15-0012
Effective Theories for Dark Matter Nucleon Scattering
Junji Hisano, Ryo Nagai, Natsumi Nagata
JHEP **05** (2015) 037, date of acceptance 2015.04.17, arXiv:1502.02244 [hep-ph]

IPMU15-0013
IceCube potential for detecting the Q-ball dark matter in gauge mediation
Shinta Kasuya, Masahiro Kawasaki,Tsutomu T. Yanagida
Prog. Theor. Exp. Phys. **2015**, 053B02 (2015), arXiv:1502.00715 [hep-ph]

IPMU15-0014
Primordial black holes as biased tracers
Yuichiro Tada, Shuichiro Yokoyama
Phys. Rev. D **91**, 123534 (2015), arXiv:1502.01124 [astro-ph]

IPMU15-0015
Accessing the core of the naturalness, degenerated Higgsinos, with the LHC
Chengcheng Han, Doyoun Kim, Shoaib Munir, Myeonghun Park
JHEP **04** (2015) 132, arXiv:1502.03734 [hep-ph]

IPMU15-0016
Gravitational waves from unstable domain walls in the Standard Model Higgs potential
Naoya Kitajima, Fuminobu Takahashi
Phys.Lett. B **745**, 112-117 (2015), arXiv:1502.03725 [hep-ph]

IPMU15-0017
Affleck-Dine baryogenesis after D-term inflation and solutions to the baryon-DM coincidence problem
Masahiro Kawasaki, Masaki Yamada
Phys. Rev. D **91**, 083512 (2015), arXiv:1502.03550 [hep-ph]

IPMU15-0018
Footprints of Supersymmetry on Higgs Decay
Motoi Endo, Takeo Moroi, Mihoko M. Nojiri
JHEP **04** (2015) 176, arXiv:1502.03959 [hep-ph]

IPMU15-0019
More on the equivalence between f(R) gravity and quintessence in inflationary models
S.V. Ketov, A.A. Starobinsky

IPMU15-0020
Dark Matter and Gauge Coupling Unification in Non-supersymmetric SO(10) Grand Unified Models
Yann Mambrini, Natsumi Nagata, Keith A. Olive, Jeremie Quevillon, Jiaming Zheng
Phys. Rev. D **91**, 095010 (2015), date of acceptance 2015.04.20, arXiv:1502.06929 [hep-ph]

IPMU15-0021
The phase factors in singularity theory
Todor Milanov
arXiv:1502.07444 [math]

IPMU15-0022
Membranes and higher groupoids
Mikhail Kapranov
arXiv:1502.06166 [math]

IPMU15-0023
Detection of universality of dark matter profile from Subaru weak lensing measurements of 50 massive clusters
Hiroko Niikura, Masahiro Takada, Nobuhiro Okabe, Rossella Martino, Ryuichi Takahashi
arXiv:1504.01413 [astro-ph]

IPMU15-0024
Surface/State Correspondence as a Generalized Holography
Masamichi Miyaji, Tadashi Takayanagi
Prog. Theor. Exp. Phys. **2015**, 073B03 (2015), arXiv:1503.03542 [hep-th]

IPMU15-0025
Positive Casimir and Central Characters of Split Real Quantum Groups
Ip Ivan Chi-Ho
arXiv:1503.00543 [math]

IPMU15-0026
Study of electron anti-neutrinos associated with gamma-ray bursts using KamLAND
KamLAND collaboration (K. Asakura et al.)
Astrophys. J. **806**, 87 (2015), arXiv:1503.02137 [astro-ph]

IPMU15-0027
Low-energy Supersymmetry Breaking Without the Gravitino Problem
Anson Hook, Hitoshi Murayama
Phys. Rev. D **92**, 015004 (2015), arXiv:1503.04880 [hep-ph]

IPMU15-0028
6d N=(1,0) theories on T2 and class S theories: Part I
K. Ohmori, H. Shimizu, Y. Tachikawa, K. Yonekura
JHEP **07** (2015) 014, arXiv:1503.06217 [hep-th]

IPMU15-0029
Consistent generation of magnetic fields in axion inflation models
Tomohiro Fujita, Ryo Namba, Yuichiro Tada, Naoyuki Takeda, Hiroyuki Tashiro
JCAP **05** (2015) 54, arXiv:1503.05802 [astro-ph]

IPMU15-0030
Flavor violating Z' from SO(10) SUSY GUT in High-Scale SUSY
J. Hisano, Y. Muramatsu, Y. Omura, M. Yamanaka
Phys.Lett. B **744**, 395-400 (2015), arXiv:1503.06156 [hep-ph]

IPMU15-0031
Gravitational waves from domain walls in the next-to-minimal supersymmetric standard model
Kenji Kadota, Masahiro Kawasaki, Ken'ichi Saikawa
JCAP **10** (2015) 41, arXiv:1503.06998 [hep-ph]

IPMU15-0032
Predictions for the Leptonic Dirac CP Violation Phase: a Systematic Phenomenological Analysis
I. Girardi, S. T. Petcov, A. Titov
Eur. Phys. J. C**75**, 345 (2015), arXiv:1504.00658 [hep-ph]

IPMU15-0033
Scrambling time from local perturbations of the eternal BTZ black hole
Pawe Caputa, Joan Simon, Andrius Stikonas, Tadashi Takayanagi, Kento Watanabe
JHEP **08** (2015) 011, arXiv:1503.08161 [hep-th]

IPMU15-0034
On skein relations in class S theories
Yuji Tachikawa, Noriaki Watanabe
JHEP **06** (2015) 186, arXiv:1504.00121 [hep-th]

IPMU15-0035
Threshold Corrections to Baryon Number Violating Operators in Supersymmetric SU(5) GUTs
J. Hisano, T. Kuwahara, Y .Omura
Nucl. Phys. B **898**, 1-29 (2015), arXiv:1503.08561 [hep-ph]

IPMU15-0036
Leptogenesis during Axion Relaxation after Inflation
Kai Schmitz
arXiv:1503.08908 [hep-ph]

12 CONFERENCE PRESENTATIONS AND SEMINAR TALKS

Seminar talks given at the Kavli IPMU are not included. For seminar talks given at the Kavli IPMU, see Section 8.

FY2014

Workshop on Hyper-accretion
(2014.04.07–2014.04.11, Kavli IPMU)
Andreas Schulze
The cosmic growth of the active black hole population

17th Workshop on "Nuclear Astrophysics"
(2014.04.07–2014.04.12, Ringberg, Germany)
Ken'ichi Nomoto
Progenitors of Type I Supernovae

Focus Week on Hyper Accretion
(2014.04.09, Kashiwa)
Naoki Yoshida
Formation of Early Blackholes

Kamioka Seminar
(2014.04.09, Kamioka Observatory, ICRR, U Tokyo)
Haruki Nishino
CMB B-mode Polarization Experiments: First Results from POLARBEAR (and Review on Recent Discovery by BICEP2)

Nagoya U C-lab seminar
(2014.04.10, Nagoya U)
Teppei Okumura
Precise modeling of redshift space distortion effect in galaxy surveys using phase-space distribution function approach

Colloquium talk
(2014.04.14, Ehime U)
Malte Schramm
Constraints on BH-Galaxy Co-Evolution over the past 12 billion years

Cosmological Quests for the Next Decade
(2014.04.16–2014.04.18, KASI, Korea)
Masahiro Takada
Super sample effects in cosmological surveys

Cosmological Quests for the Next Decade
(2014.04.16–2014.04.18, KASI, Daejeon, Korea)
Teppei Okumura
Nonlinear velocity statistics and redshift-space distortions in peculiar velocity surveys

PONT 2014
(2014.04.17, Avignon, France)
Shinji Mukohyama
Massive gravity and cosmology

The Rosseland Lecture 2014
(2014.05.06, U Oslo, Oslo, Norway)
Hitoshi Murayama
The Quantum Universe

Invited review talk
(2014.05.07, Institute of Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Sofia, Bulgaria)
Serguey T. Petcov
Neutrino Masses, Mixing and Oscillations: Current Status and Future Prospects

String Duality Seminar
(2014.05.08, Harvard U, Massachusetts, USA)
Hitoshi Murayama
Generalized Goldstone theorem

Equivariant Gromov-Witten Theory and Applications
(2014.05.12–2014.05.16, Simons Center for Geometry and Physics, Stony Brook, USA)
Kentaro Hori
The Hemisphere Parition Function

ASIAA Colloquium
(2014.05.13, Taipei, Taiwan)
Naoki Yoshida
The Dark Age of the Universe

Stanford Institute for Theoretical Physics theory seminar
(2014.05.15, Stanford U, USA)
Jonathan David Maltz
Deconfinement Transistion as black Hole formation as the condensation of QCD strings

From Dark Matter to Galaxies
(2014.05.18–2014.05.23, Xi'an, China)
Masahiro Takada
The large-scale structure of the Universe: the current status and future prospects

From Dark Matter to Galaxies
(2014.05.18–2014.05.23, Xi'an, China)
Teppei Okumura
Peculiar velocity in redshift space: formalism, N-body simulations and perturbation theory

Vulcano Workshop 2014–Frontier objects in Astrophysics and Particle Physics
(2014.05.18–2014.05.24, Vulcano, Italy)
Stavros Katsanevas
Astroparticle Physics Planning in Europe

Representations of reductive groups: A conference dedicated to David Vogan on his 60th birthday
(2014.05.19–2014.05.23, MIT, USA)
Toshiyuki Kobayashi
Branching problems of representations of real reductive Lie groups.

IAS Workshop on New Perspectives on Cosmology
(2014.05.19–2014.05.23, IAS, Hong Kong U Science and Technology)
Ryo Namba
Blue Tensor Spectrum from Particle Production during Inflation

Seminar at KEK theory group
(2014.05.20, KEK)
Shun Saito
Neutrino mass constraint from robust cosmological signals in the BOSS DR11 galaxy clustering

Physics seminar
(2014.05.22, Osaka U)
Hitoshi Murayama
What's wrong with Goldstone?

Nambu Coloquium
(2014.05.22, Osaka U)
Hitoshi Murayama
From magnets to the Higgs boson

IAS Workshop on New Perspectives on Cosmology
(2014.05.23, Hong Kong)
Shinji Mukohyama
Massive gravity and cosmology

Overcoming Great Barriers in Galactic Archaeology 2
(2014.05.24–2014.06.02, Palm Cove, Australia)
Chiaki Kobayashi
On the Origin of variation in elemental abundance ratios

IAU Symposium 306: Statistical challenges in 21st century cosmology
(2014.05.25–2014.05.29, Lisbon, Portugal)
Masahiro Takada
Statistical challenges in weak lensing cosmology (keynote talk)

Workshop on "Particle Physics & Cosmology Symposium 2014 (SPCS2014)"
(2014.05.26–2014.05.30, Shanghai Jiao Tong U, Shanghai, China)
Ken'ichi Nomoto
Observations and Models of Hypernovae

Low Energy Challenges for High Energy Physicists
(2014.05.26–2014.05.30, Perimeter Institute, Ontario, Canada)
Hitoshi Murayama
What's wrong with Goldstone?

Seminar at Kanazawa U
(2014.05.28, Kanazawa U)
Shigeki Matsumoto
Dark matter phenomenology

Forschungsseminar "Algebraische Geometrie"
(2014.05.28, Humboldt Universitat zu Berlin, Germany)
Charles Siegel
Trees and an Affine Cover of \overline{_M}_{0,n+1}

Seminar at Komaba
(2014.05.29, Komaba, U Tokyo)
Shinji Mukohyama
Blue Tensor Spectrum from Particle Production during Inflation

Series of lectures at Toyama U
(2014.05.29–2014.05.30, Toyama U)
Shigeki Matsumoto
What is dark matter?

Seminar at Toyama U
(2014.05.30, Toyama U)
Shigeki Matsumoto
Observing gamma-rays from dSphs

Symposium 2014 "The Physical Origin of the Universe viewed through the Cosmic Background Radiation"
(2014.06.02–2014.06.03, RIKEN Wako Campus)
Haruki Nishino
POLARBEAR-1

The transient universe as seen by iPTF and ZTF
(2014.06.02–2014.06.05, Albanova U Centre, Stockholm, Sweden)
Melina Bersten
A binary progenitor for the Type Ib Supernova iPTF 13bvn

1st workshop on galaxy evolution
(2014.06.04, NAOJ)
Shun Saito
Implication of evolution of massive galaxies from the small-scale galaxy clustering in the BOSS CMASS sample

Seminar at ICRR/IPMU
(2014.06.05, ICRR)
Haruki Nishino
CMB B-mode polarization experiments: Recent results from POLARBEAR (and BICEP2)

1st APCTP-TUS workshop on Dark Energy
(2014.06.05, Pohang, Korea)
Shinji Mukohyama
Massive gravity and Cosmology

XVIth International Conference on Geometry, Integrability and Quantization
(2014.06.06, Varna, Bulgaria)
Toshiyuki Kobayashi
Finite-dimensional Multiplicity-free Representations

Geometry, Integrability and Quantization
(2014.06.07, Varna, Bulgaria)
Toshiyuki Kobayashi
Infinite-dimensional Multiplicity-free Representations

Geometry, Integrability and Quantization
(2014.06.09, Varna, Bulgaria)
Toshiyuki Kobayashi
Visible Actions on Complex Manifolds

Seminar at Academia Sinica
(2014.06.09, Academia Sinica, Taiwan)
Natsumi Nagata
Formulation of effective theories for the dark matter direct detection

Edge days 2014
(2014.06.09–2014.06.11, U Edinburgh, UK)
Ilya Karzhemanov
On S6-invariant quartics

String-Math 2014
(2014.06.09–2014.06.13, U Alberta, Edmonton, Canada)
Kentaro Hori
1d Index and Wall Crossing

Physics of First Star and Galaxy Formation
(2014.06.10, Edinburgh, UK)
Naoki Yoshida
Formation of Primordial Stars

Geometry seminar
(2014.06.10, Tohoku U)
Yohsuke Imagi
Uniqueness of desingularization of special Lagrangian submanifolds

Geometry, Integrability and Quantization
(2014.06.10, Varna, Bulgaria)
Toshiyuki Kobayashi
Propagation Theorem under Visible Actions

Geometry, Integrability and Quantization
(2014.06.11, Varna, Bulgaria)
Toshiyuki Kobayashi
Applications of Operator Valued Reproducing Kernels

AG Seminar
(2014.06.11, U Cambridge, UK)
Ilya Karzhemanov
Uniformly rational varieties

The Fermilab Annual Users Meeting
(2014.06.11–2014.06.12, Fermilb, Illinois,USA)
Hitoshi Murayama
The Quantum Universe

Seminar at National Taiwan U
(2014.06.12, National Taiwan U, Taiwan)
Natsumi Nagata
Formulation of effective theories for the dark matter direct detection

the 2nd International Symposium on Science at J-PARC (J-PARC 2014)
(2014.06.12–2014.06.15, EPOCHAL TSUKUBA, Ibaraki)
Hitoshi Murayama
Particle and Nuclear Physics

Seminar at Kyusyu U
(2014.06.13, Kyusyu U)
Shigeki Matsumoto
Dark matter wants SUSY?

Seminar at NAOJ
(2014.06.13, NAOJ)
Haruki Nishino
First Results from CMB Polarization Experiment POLARBEAR

Informal Seminar at National Central U
(2014.06.13, National Central U, Taiwan)
Natsumi Nagata
Formulation of effective theories for the dark matter direct detection

Seminar at Waseda U
(2014.06.16, Waseda U)
Shun Saito
Towards an accurate modeling of halo/galaxy clustering at quasi-linear regime

GDR Neutrino Meeting
(2014.06.16, LAL, Universite' de Paris-sud, Orsay, France)
Serguey T. Petcov
Observables in Neutrino Mass Spectroscopy Using Atoms

The X-ray Universe 2014
(2014.06.16–2014.06.19, Dublin, Ireland)
Nobuhiro Okabe
A Comparison of Weak-lensing and X-ray masses of Galaxy Clusters

Seminar of symplectic geometry and mathematical physics
(2014.06.18, BICMR, Peking U, Beijing)
Yefeng Shen
Mirror symmetry for exceptional unimodular singularities

Aspen workshop "Peculiar Type Ia Supernovae"
(2014.06.18–2014.06.29, Aspen Center for Physics, Aspen, USA)
Ken'ichi Nomoto
Progenitors of Neutron Star Forming Supernovae

Seminar at U Nottingham
(2014.06.20, Nottingham, UK)
Shinji Mukohyama
From configuration to dynamics

Seminar at U Nottingham
(2014.06.20, Nottingham, UK)
Shinji Mukohyama
Massive gravity and cosmology

3rd Workshop on Next Generation Accelerator-based Neutrino Experiment
(2014.06.21–2014.06.22, Kyoto U)
Shigeki Matsumoto
Neutrinos at IceCube from Heavy Decaying DM

PASCOS 2014
(2014.06.22–2014.06.27, Warsaw, Poland)
Natsumi Nagata
Sfermion Flavor and Proton Decay in Minimal SU(5) GUT with High-scale SUSY

PASCOS 2014
(2014.06.23, Warsaw, Poland)
Serguey T. Petcov
Theory Prospective on Neutrino Masses, Mixing and Leptonic CP Violation

SPIE conference "Astronomical Telescopes + Instrumentation"
(2014.06.23, Montreal, Canada)
Hajime Sugai
Progress with the Prime Focus Spectrograph for the Subaru Telescope: a massively multiplexed optical and near-infrared fiber spectrograph

Higgs Modes in Condensed Matter and Quantum Gases
(2014.06.23–2014.06.25, YITP)
Hitoshi Murayama
Higgs and Goldstone bosons with and without Lorentz invariance

Algebra, Geometry and Physics: a conference in honour of Maxim Kontsevich
(2014.06.23–2014.06.27, IHES, Paris, France)
Mikhail Kapranov
Algebra of the infrared and secondary polytopes

New windows on massive stars: asteroseismology, interferometry, and spectropolarimetr
(2014.06.23–2014.06.27, Geneva, Switzerland)
Melina Bersten
The First Evidence of a Binary Progenitor for a Type Ib Supernova

Strings 2014
(2014.06.23–2014.06.27, Princeton U, USA)
Jonathan David Maltz
Deconfinement Transistion as black Hole formation as the condensation of QCD strings

Derived categories
(2014.06.23–2014.06.27, Nantes, France)
Yukinobu Toda
Stability conditions and Donaldson-Thomas invariants

Summer School in Gromov-Witten Theory 2014
(2014.06.23–2014.07.04, Pingree Park campus, Colorado State U)
Yefeng Shen
1(+1) proof(s) of modularity of GW correlation functions for elliptic orbifolds

Seminar at Scuola Normale Superiore
(2014.06.25, Scuola Normale Superiore, Pisa, Italy)
Shinji Mukohyama
Massive gravity and cosmology

invited lectures
(2014.06.28–2014.06.30, CERN-JINR International School of High Energy Physics, Gardener, The Netherlands)
Serguey T. Petcov
Neutrino Physics (Neutrino Masses, Mixing, Oscillations, Leptonic CP Violation and Beyond)

7th International Conference on New Developments in Photodetection
(2014.06.30–2014.07.04, Tours, France)
Stavros Katsanevas
Astroparticle Physics and Photodetector

European Week of Astronomy and Space Science (EWASS) 2014
(2014.06.30–2014.07.04, Geneva, Switzerland)
Stavros Katsanevas
A European and global Roadmap for Astroparticle Physics

Topology Seminar
(2014.07.01, Komaba, U Tokyo)
Yohsuke Imagi
Singularities of Special Lagrangian Submanifolds

Maskawa Institute seminar
(2014.07.02, Maskawa Institute, Kyoto Sangyo U)
Natsumi Nagata
High-scale supersymmetry explored with non-accelerator precise measurement experiments

ICHEP2014
(2014.07.02–2014.07.09, Valencia, Spain)
Haruki Nishino
First Results from CMB Polarization Experiment POLARBEAR

Unsolved Problems in Astrophysics
(2014.07.03, Budapest, Hungary)
Naoki Yoshida
Structure Formation in the Early Universe

Colloquium at ICRR
(2014.07.04, ICRR)
Shun Saito
Toward a robust constraint on neutrino masses from galaxy clustering

Joint Meeting among RESCEU-RIKEN-IPMU @RIKEN
(2014.07.07–2014.07.08, RIKEN (Wako))
Miho N. Ishigaki
Chemical abundances in extremely metal-poor stars in the Milky Way halo and in dwarf satellite galaxies

Nuclei in the Cosmos XIII
(2014.07.07–2014.07.11, Debrecen, Hungary)
Chiaki Kobayashi
Inhomogeneous enrichment in chemodynamical simulations of galaxies

INT 14-2a Program "Binary Neutron Star Coalescence as a Fundamental Physics Laboratory"
(2014.07.07–2014.07.25, Institute for Nuclear Theory (INT), U Washington, Seattle, USA)
Ken'ichi Nomoto
Progenitors of Neutron Star Forming Supernovae"

Waseda U Seminar
(2014.07.10, Waseda U)
Natsumi Nagata
Proton Decay in High-scale Supersymmetry

Cosmology Seminar at Waseda U
(2014.07.11, Waseda U)
Ryo Namba
Statistical anisotropy from anisotropic inflation in a vector curvaton model

Seminar at ETH Zürich
(2014.07.11, ETH Zürich, Switzerland)
Andreas Schulze
The cosmic growth of the active black hole population

Colloquium, U Tokyo
(2014.07.11, U Tokyo)
Toshiyuki Kobayashi
Global Geometry and Analysis on Locally Symmetric Spaces with Indefinite-metric

Representation Theory and Groups Actions,
(2014.07.12, U Tokyo)
Toshiyuki Kobayashi
Branching Problems of Representations of Real Reductive Groups

CRC town meeting
(2014.07.12–2014.07.13, Nagoya U)
Shigeki Matsumoto
The most promising DM candidate

The 10th Regular Meeting of New Higgs Working Group
(2014.07.12–2014.07.13, U Toyama)
Natsumi Nagata
Theoretical Calculation for Neutron EDM

Institute for Advanced Study SNS Theory seminar
(2014.07.14, Institute for Advanced Study–Princeton U)
Jonathan David Maltz
Effective String Theory Simplified

Clustering Measurements of Active Galactic Nuclei
(2014.07.14–2014.07.18, ESO, Garching, Germany)
Andreas Schulze
HETDEX: AGN-galaxy clustering at 2<z<3.5

Summer camp on ILC accelerator and physics/detector 2014
(2014.07.19–2014.07.22, Sekigane, Tottori)
Shigeki Matsumoto
Comprehensive dark matter searches at the ILC

Combining probes in cosmological surveys
(2014.07.20, Aspen Center for Physics, Aspen, CO)
Masahiro Takada
Hyper Suprime-Cam

Combining probes in cosmological surveys
(2014.07.20–2014.08.10, Aspen Center for Physics, Aspen, CO)
Masahiro Takada
Super sample covariance/signal

IAU Symposium 311 "Galaxy Masses as Constraints of Formation Models"
(2014.07.21–2014.07.25, Oxford, UK)
Kevin Bundy
MaNGA: Mapping Nearby Galaxies at APO

RSD Workshop
(2014.07.21–2014.07.25, Sexten, Italy)
Teppei Okumura
Modeling nonlinear power spectrum of galaxies in redshift Space

Strings and Fields
(2014.07.22–2014.07.26, YITP, Kyoto U)
Richard Eager
Superconformal field theories and cyclic homology

Geometry and Physics of Gauged Linear Sigma Models
(2014.07.28–2014.08.01, IAS, Seoul, Korea)
Kentaro Hori
Gauge Theory Duality and Linear Sigma Models

RIMS Project 2014 Geometric Representation Theory
(2014.07.28–2014.08.01, Kyoto U)
Mikhail Kapranov
Perverse sheaves on real hyperplane arrangements

INT Conference 14-56w "The r-process: status and challenges"
(2014.07.28–2014.08.01, Institute for Nuclear Theory (INT), U Washington, Seattle, USA)
Ken'ichi Nomoto
Hypernova Nucleosynthesis

AGN vs. Star Formation
(2014.07.28–2014.08.01, Durham U, UK)
Claire Lackner
Double yolk galaxies: late-stage galaxy mergers in COSMOS

Seoul ICM 2014 satellite conference: Geometry and physics of gauged linear sigma model and its related topics
(2014.07.28–2014.08.01, KIAS, Seoul, Korea)
Yefeng Shen
Modularity of Gromov-Witten correlation functions for elliptic orbifold curves

Seoul ICM 2014 satellite conference: Geometry and physics of gauged linear sigma model and its related topics
(2014.07.28–2014.08.01, Korea Institute for Advanced Study, Korea)
Richard Eager
Supersymmetric gauge theories and the hemisphere partition function

Seoul ICM 2014 Satellite Conference: GLSM
(2014.07.28–2014.08.01, KIAS, Korea)
Yukinobu Toda
Generalized Donaldson-Thomas invariants on the local projective plane

3rd International Conference on New Frontiers in Physics
(2014.07.29–2014.08.06, Crete, Greece)
Lluis Marti-Magro
EGADS approaching GADZOOKS!

Homological mirror symmetry and symplectic topology
(2014.08.04–2014.08.08, IBS-CGP, POSTECH)
Changzheng Li
Mirror symmetry for exceptional unimodular singularities

Workshops on "Supernova and Transient"
(2014.08.06–2014.08.08, Mt. Stromlo, Canberra, Australia)
Ken'ichi Nomoto
Nucleosynthesis in Massive Stars

Tsuda College Workshop on Calabi-Yau varieties: arithmetic, geometry and physics
(2014.08.07–2014.08.08, Tsuda College)
Yukinobu Toda
Generalized Donaldson-Thomas invariants on the local projective plane

Seoul ICM 2014 Satellite Conference on Topology of Torus Actions and Applications to Geometry and Combinatorics
(2014.08.07–2014.08.11, Daejeon, Korea)
Changzheng Li
On equivariant Pieri rules for isotropic Grassmannians

Exact Results in SUSY Gauge Theories in Various Dimensions
(2014.08.11–2014.08.22, CERN, Geneva, Switzerland)
Kentaro Hori
Witten Index and Wall Crossing

Seoul ICM
(2014.08.11–2014.08.22, COEX, Seoul, Korea)
Yukinobu Toda
Derived category of coherent sheaves and counting invariants

International Congress of Mathematicians
(2014.08.12–2014.08.21, Seoul, Korea)
Charles Siegel
The Moduli of Klein Covers of Curves

Series of lectures at Shimane U
(2014.08.13–2014.08.15, Shimane U)
Shigeki Matsumoto
Particle physics of Dark Matter

Geometry Colloquium
(2014.08.14–2014.08.15, Hokkaido U)
Yefeng Shen
LG/CY correspondence for elliptic orbifold curves and modular forms

Under ground experiments
(2014.08.23–2014.08.24, Osaka U)
Shigeki Matsumoto
A Comprehensive Study of WIMP DM in Effective Theory Approach

Geometry Symposium
(2014.08.23–2014.08.26, Meijo U)
Yohsuke Imagi
Uniqueness of desingularization of special Lagrangian submanifolds

NuFACT 2014
(2014.08.25–2014.08.30, Glasgow, Scotland)
Christophe Bronner
T2K neutrino oscillation results

Workshop on Synergy of HSC and Hiroshima CORE-U projects for Galaxy Clusters and Astronomical Transients
(2014.08.27, Hiroshima U)
Nobuhiro Okabe
A Joint Approach of HSC WL and Astro-H (SXS/SXI/HXI) to Cluster Sciences

New developments in Algebraic Geometry
(2014.09.01–2014.09.04, National Taiwan U)
Yukinobu Toda
Stable pair invariants on Calabi-Yau 3-folds containing P^2

Prehomogeneous Vector Spaces and Related Topics
(2014.09.01–2014.09.05, Rikkyo U)
Toshiyuki Kobayashi
Symmetry Breaking Operators for Rank One Orthogonal Groups

G2 manifolds
(2014.09.02–2014.09.05, Stony Brook)
Yohsuke Imagi
Singularities of Special Lagrangian Submanifolds

Neutrino Oscillation Workshop 2014
(2014.09.07–2014.09.14, Otranto, Lecce, Italy)
Stavros Katsanevas
Neutrino and Astroparticle Physics: Perspectives (concluding remarks)

GOPIRA Symposium 2014 "Prospects of optical and infrared astronomy"
(2014.09.08–2014.09.10, NAOJ)
Masahiro Takada
Cosmology in 2020

astrophys colloquium
(2014.09.11, Jet Population Lab, USA)
Kevin Bundy
MaNGA: Mapping Nearby Galaxies at APO

GTM seminar
(2014.09.11, IPMU)
Yohsuke Imagi
Singularities of Special Lagrangian Submanifolds

ASJ 2014 autumn meeting
(2014.09.11–2014.09.13, Yamagata U)
Naoyuki Tamura
Summary and current status of SuMIRe-PFS project in 2014

astrophys seminar
(2014.09.12, UC Irvine, USA)
Kevin Bundy
MaNGA: Mapping Nearby Galaxies at APO

astronomy tea talk
(2014.09.15, Caltech, USA)
Kevin Bundy
MaNGA: Mapping Nearby Galaxies at APO

Workshop on "Type Ia Supernovae: Progenitors, Explosions, and Cosmology"
(2014.09.15–2014.09.19, U Chicago, Chicago, USA)
Ken'ichi Nomoto
Final Evolution of Spinning White Dwarfs and their Companions in Single Degenerate Models for Type Ia Supernovae

Relativistic Cosmology
(2014.09.16, YITP, U Kyoto)
Masahiro Takada
Super-Sample Covariance/Signal

JPS conference
(2014.09.18–2014.09.21, Saga U)
Shigeki Matsumoto
Beyond SM @ HL-LHC

Particle Cosmology after Planck
(2014.09.23–2014.09.26, DESY, Germany)
Tsutomu Yanagida
What is the origin of the shift symmetry ?

Autumn meeting of the Mathematical Society of Japan
(2014.09.25–2014.09.28, Hiroshima U)
Toshitake Kohno
Iterated integrals and de Rham homotopy theory, Featured special lecture

HEFT2014–Higgs Effective Field Theories
(2014.09.28–2014.09.30, Instituto de Fisica Teorica, Madrid, Spain)
Hitoshi Murayama
Power of Precision Higgs Measurements on Hierarchy Problem and Baryogenesis

CTA conference
(2014.10.02–2014.10.03, Kashiwa)
Shigeki Matsumoto
WIMIP DM & Gamma-ray observations

Algebraic Geometry Seminar
(2014.10.06, Zurich U, Switzerland)
Toshiyuki Kobayashi
Symmetry Breaking Operators and Branching Problems

Fine tuning, Anthropics and String Landscape
(2014.10.08–2014.10.10, IFT, U. Autonoma de Madrid, Spain)
Taizan Watari
Statistics of Gauge Group and the Number of Generations

Braids and Arithmetics
(2014.10.14–2014.10.17, CIRM, Luminy, France)
Toshitake Kohno
Quantum symmetry of conformal blocks and representations of braid groups at roots of unity

EHQG seminar
(2014.10.28, Nagoya U)
Michihisa Takeuchi
Boosted Higgs shapes at LHC

Algebra and Combinatorics Seminar
(2014.11.03, North Carolina State U, USA)
Todor Milanov
Fano orbifold curves and integrable hierarchies

Gauged Sigma-Models in Two Dimensions
(2014.11.03–2014.11.07, Simons Center for Geometry and Physics, Stony Brook, USA)
Kentaro Hori
Grade Restriction Rule for Rodland Model and Pfaffian/Grassmann Correspondence, via Hemisphere Partition Function

The 24th Workshop on General Relativity and Gravitation (JGRG24)
(2014.11.10–2014.11.14, Kavli IPMU)
Ryo Namba
Toward constructing ghost-free scalar-tensor theories beyond Horndeski

K3, Enriques surfaces and related topics
(2014.11.10–2014.11.14, Nagoya U)
Yukinobu Toda
Stable pair invariants on Calabi-Yau 3-folds containing P^2

Astroparticle physics workshop: The future in South America
(2014.11.12–2014.11.14, Institute of Phys., U Sao-Paulo, Brazil)
Stavros Katsanevas
The organization of big facilities

Caltech Theory Seminar
(2014.11.14, Caltech, USA)
Jonathan David Maltz
Deconfinement Transistion as black Hole formation as the condensation of QCD strings

IPMU+ICRR public lecture
(2014.11.15, Komaba, U Tokyo)
Shigeki Matsumoto
What is dark matter?

colloquia
(2014.11.17, KIAA, Beijing, China)
Kevin Bundy
MaNGA: Mapping Nearby Galaxies at APO

Wide-field InfraRed Surveys: Science and Techniques
(2014.11.17–2014.11.20, Pasadena, USA)
Masahiro Takada
Dark energy interests in Japan: Subaru SuMIRe project

UCLA theory Seminar
(2014.11.18, UCLA)
Jonathan David Maltz
Deconfinement Transistion as black Hole formation as the condensation of QCD strings

ENZO Workshop 2014
(2014.11.18–2014.11.21, Hokkaido U)
Shun Saito
A Lazy Path to Model the Galaxy-Halo Connection for the BOSS CMASS sample

2014 A3 Foresight Program Conference on Modeling and Computation of Applied Inverse Problems
(2014.11.21–2014.11.23, International Convention Center, Jeju, Korea)
Toshitake, Kohno
Interaction between geometry and quantum field theory

Stanford Institute for theoretical physics theory seminar
(2014.11.24, Stanford U, USA)
Jonathan David Maltz
Effective String Theory Simplified

UCSB theory seminar
(2014.11.25, UCSB, USA)
Jonathan David Maltz
Deconfinement Transistion as black Hole formation as the condensation of QCD strings

Symposium on Representation Theory 2014
(2014.11.25–2014.11.28, Awajishima)
Toshiyuki Kobayashi
Symmetry Breaking Operators and Branching Problems

2nd Matsue Phenomenology workshop
(2014.11.28–2014.11.30, Matsue, Shimane U)
Shigeki Matsumoto
Detecting 100TeV WIMP

Astroparticle seminar at UC Riverside
(2014.12.02, Riverside, USA)
Naoki Yoshida
Matter Distribution around Galaxies

UCLA Astronomy Colloquium
(2014.12.03, Los Angels, USA)
Naoki Yoshida
Formation of Primordial Stars and Galaxies

Seminar @ Kyoto U
(2014.12.03, Kyoto U)
Shigeki Matsumoto
Dark Matter Candidates in Standard Cosmology

CRA Distinguished Lecture
(2014.12.05, Atlanta, USA)
Naoki Yoshida
Putting the Universe on a Computer

Analysis, Geometry and Representations on Lie Groups and Homogeneous Spaces
(2014.12.08–2014.12.12, Marrakech, Morocco)
Toshiyuki Kobayashi
Symmetry Breaking Operators for Rank One Orthogonal Groups

CosPA 2014
(2014.12.08–2014.12.12, U Auckland, New Zealand)
Tsutomu Yanagida
Chotic inflation from particle physics

Differential Topology Seminar
(2014.12.09, Kyoto U)
Yohsuke Imagi
Singularities of special Lagrangian submanifolds

Simons Center theory seminar
(2014.12.09, The Simons Center at Stoney Brook, USA)
Jonathan David Maltz
Deconfinement Transistion as black Hole formation as the condensation of QCD strings

Colloquium, Tohoku U
(2014.12.15, Sendai)
Toshiyuki Kobayashi
Global Geometry and Analysis on Locally Symmetric Spaces with Indefinite-metric.

Master Lecture in Mathematics
(2014.12.15–2014.12.19, Tsinghua Sanya International Mathematics Forum)
Yukinobu Toda
Stable pair invariants on Calabi-Yau 3-folds containing P^2

Miniworkshop on Cosmology
(2014.12.17–2014.12.20, APCTP, Pohang, Korea)
Ryo Namba
Cosmological implications from interactions between a pseudo-scalar inflaton and gauge field

Primitive forms, mirror symmetry and related topics 2014
(2014.12.24–2014.12.26, Kyoto U)
Todor Milanov
Mirror symmetry and the global ancestor potential

Primitive Forms, Mirror Symmetry and Related Topics 2014
(2014.12.24–2014.12.26, Kyoto U)
Yukinobu Toda
Non-commutative width and Gopakumar-Vafa invariants

Primitive Forms, Mirror Symmetry and Related Topics 2014
(2014.12.24–2014.12.26,, Department of Mathematics, Kyoto U , Kyoto)
Kentaro Hori
Grade Restriction Rule in Rodland Model

UK-Japan Winter School "Topology and Integrability"
(2015.01.05–2015.01.08, Loughborough U, UK)
Toshitake Kohno
Braids, Quantum symmetry and Hypergeometric integrals

RIKKYO MathPhys 2015: Gauge Theory, CFT and Integrability
(2015.01.10–2015.01.12, Rikkyo U)
Alexander A. Voronov
r∞-Matrices and quantum ∞-groups

RIKKYO MathPhys 2015: Gauge Theory, CFT and Integrability
(2015.01.10–2015.01.12, Rikkyo U)
Taizan Watari
Geometry of elliptic K3, elliptic CY fourfold and F-theory

physics colloquium
(2015.01.13, UCSB, USA)
Kevin Bundy
Why do galaxies die?

Subaru Users Meeting
(2015.01.13–2015.01.15, NAOJ, Mitaka)
Naoyuki Tamura
Prime Focus Spectrograph

Colloquium
(2015.01.15, Kyushu U)
Toshiyuki Kobayashi
Global Geometry and Analysis on Locally Symmetric Spaces: Beyond Riemannian Geometry

Workshop on first stars and first galaxies
(2015.01.19–2015.01.21, Tohoku U)
Miho N. Ishigaki
Chemical compositions of ultra-faint dwarf spheroidal galaxy Boötes I

MPIA Galaxy Coffee
(2015.01.22, MPIA, Heidelberg, Germany)
Andreas Schulze
The cosmic growth of the active black hole population

MPE High-Energy Group Seminar
(2015.01.26, MPE, Garching, Germany)
Andreas Schulze
The cosmic growth of the active black hole population out to z=2

The Tenth East Asian School of Knots and Related Topics
(2015.01.26–2015.01.29, East China Normal U, Shanghai, China,)
Toshitake Kohno
Higher holonomy of braids

Bogomolov-Gieseker type inequality and counting invariants
(2015.01.26–2015.01.30, Miami U)
Yukinobu Toda
Homological mirror symmetry and geometry

Conference on Homological Mirror Symmetry and Geometry
(2015.01.26–2015.01.31, U Miami, USA)
Mikhail Kapranov
Perverse Schobers and Fukaya categories with coefficients

Exploring the Physics Frontier with Circular Colliders
(2015.01.26–2015.02.01, Aspen Center For Physics, Colorado, USA)
Hitoshi Murayama
ILC

INAF-OABO Seminar
(2015.01.28, INAF-Osservatorio Astronomico di Bologna, Italy)
Andreas Schulze
The cosmic growth of the active black hole population out to z=2

KEK Theory Workshop 2015
(2015.01.28–2015.01.31, KEK)
Tsutomu Yanagida
What I believe now---36 years after the Seesaw discovery ---

OAR Seminar
(2015.02.03, INAF-OAR, Rome, Italy)
Andreas Schulze
The cosmic growth of the active black hole population out to z=2

International Conference on Massive Neutrinos
(2015.02.09–2015.02.13, Nanyang U, Singapore)
Christophe Bronner
Results from T2K

LHCDM workshop
(2015.02.09–2015.02.13, IACS, Kolkata, India)
Shigeki Matsumoto
Wino dark matter: Its motivation and detection

Higgs as a Probe of New Physics 2015 (HPNP2015)
(2015.02.11–2015.02.15, Toyama U)
Hitoshi Murayama
Unraveling Cosmic History with Elementary Particles

colloquium
(2015.02.16, Institute for Astronomy, U Tokyo)
Kevin Bundy
MaNGA: Mapping Nearby Galaxies at APO

Representation theory and Related Topics
(2015.02.16–2015.02.20, Irako View Hotel)
Yoshiki Oshima
Howe duality and holomorphic representations

Geometry from Stability Conditions
(2015.02.16–2015.02.20, Warwick U, UK)
Yukinobu Toda
Bogomolov-Gieseker type inequality and counting invariants

Geometry from Stability Conditions
(2015.02.16–2015.02.20, U Warwick, Coventry, UK)
Dulip Piyaratne
Fourier-Mukai transforms and stability conditions on abelian threefolds

Deformation of Discrete Groups and Related Topics
(2015.02.17–2015.02.18, Nagoya U)
Toshiyuki Kobayashi
Rigidity in geometry and spectral analysis on non-Riemnnnian locally homogeneous manifolds

Perspectives in Lie theory–Combinatorics and Algebraic Topology of Configurations
(2015.02.17–2015.02.20, Centro de Giorgi, Pisa, Italy)
Toshitake Kohno
Conformal blocks and homological representations of braid groups

Hokuriku-Shinetsu winter school
(2015.02.20–2015.02.23, Hakusanri, Ishikawa)
Shigeki Matsumoto
Dark Matter Candidates in Standard Cosmology

Physics and Geometry of F-theory 2015
(2015.02.23–2015.02.26, Max Planck Institute, Munich, Germany)
Taizan Watari
Geometry of Elliptic K3 and Heterotic-F Duality

Mini-workshop on gravity and cosmology
(2015.02.24–2015.02.27, IAP, Paris, France)
Ryo Namba
Non-linear stabilization of scalar graviton in bigravity

seminar
(2015.03, JHU, USA)
Kevin Bundy
How do galaxies grow?

seminar
(2015.03, UC Riverside, USA)
Kevin Bundy
How do galaxies grow?

XVI International Workshop on Neutrino Telescopes
(2015.03.02–2015.03.06, Palazzo Franchetti, Istituto Veneto di Scienze, Lettere ed Arti Campo S. Stefano, Venice)
Stavros Katsanevas
Perspectives in Astroparticle Physics (Concluding remarks)

Multi-Object Spectroscopy in the Next Decade: Big Questions, Large Surveys and Wide Fields
(2015.03.02–2015.03.06, Santa Cruz de La Palma, Canary Islands)
Masahiro Takada
Subaru Prime Focus Spectrograph (PFS)

Flavor and top physics @ 100 TeV workshop
(2015.03.04–2015.03.07, IHEP, Beijing China)
Michihisa Takeuchi
The Relic Neutralino Surface at a 100 TeV collider

String/M-theory compactifications and moduli stabilization
(2015.03.04–2015.03.07, Ann Arbor, U Michigan, USA)
Taizan Watari
Some thoughts on Complex Structure Moduli Inflation

JST Symposium on Big Data Application
(2015.03.05, Tokyo)
Naoki Yoshida
Statistical Computational Cosmology

Closing in on the Cosmological Model
(2015.03.08–2015.03.11, Aspen, CO, USA)
Shun Saito
Subhalo abundance matching to model the connection between the BOSS CMASS galaxies and dark matter halos

Flavor of New Physics
(2015.03.09–2015.03.10, Tokai C, KEK)
Shigeki Matsumoto
Asymmetric Dark Matter

Representation Theory
(2015.03.09–2015.03.13, Physikzentrum Bad Honnef, Germany)
Mikhail Kapranov
Microlocal sheaves and quiver varieties

Extended Theories of Gravity
(2015.03.09–2015.03.13, Nordita, Stockholm, Sweden)
Ryo Namba
Non-linear stability of scalar graviton in bigravity

OIST workshop
(2015.03.11–2015.11.17, OIST, Okinawa)
Shigeki Matsumoto
Weakly interacting composite dark matter

RTGC Seminar
(2015.03.16, UC Berkeley, USA)
Toshitake Kohno
Holonomy of braids and its 2-categrory extension

Simons Symposium
(2015.03.16–2015.03.20, Puerto Rico)
Hirosi Ooguri
Tomography from Entanglement

Algebraic Geometry
(2015.03.16–2015.03.20, Oberwolfach, Germany)
Yukinobu Toda
Moduli of Bridgeland semistable objects on 3-folds and Donaldson-Thomas invariants

Annual meeting of the Astronomical Society of Japan
(2015.03.18–2015.03.21, Osaka U)
Shun Saito
Subhalo Abundance and Age Matching to model galaxy-dark matter halo connection of the BOSS CMASS sample

ASJ annual meeting
(2015.03.18–2015.03.21, Osaka U)
Miho N. Ishigaki
Nucleosynthesis of first stars traced by chemical compositions of extremely metal-poor stars

ASJ annual meeting
(2015.03.20–2015.03.21, Osaka U)
Masahiro Takada
Science with HSC strategic survey

Mathematical Society of Japan Spring Meeting 2015
(2015.03.21–2015.03.24, Meiji U, Tokyo)
Mikhail Kapranov
Lie algebras and secondary polytopes

JPS conference
(2015.03.21–2015.03.24, Waseda U)
Shigeki Matsumoto
TeV gamma-ray from DM annihilation

PSJ annual meeting
(2015.03.23, Waseda U)
Masahiro Takada
Quest of Neutrino Masses

Milky Way Galaxy Workshop 2015 in UTokyo
(2015.03.23–2015.03.24, U Tokyo, Hongo campus)
Miho N. Ishigaki
Chemodynamical structure of the Milky Way traced by metal-poor stars

Eurostrings 2015
(2015.03.23–2015.03.26, Cambridge U, UK)
Hirosi Ooguri
Entanglement and Bootstrap

10th International Workshop on Databases in Networked Information Systems
(2015.03.25, Aizu)
Naoki Yoshida
Subaru Hyper-Suprime Cam Survey and Big Data Cosmology

Conference on the Interaction of Representation Theory with Geometry and Combinatorics
(2015.03.27–2015.03.31, U Bonn, Germany)
Mikhail Kapranov
Derived varieties of complexes and Kostant's theorem for gl(M|N)

Kavli IPMU Public Lecture "Look into the fate and nature of the Universe from recent supernova research"
(2015.03.29, Ichijo-Hall, U Tokyo)
Ken'ichi Nomoto
What are Supernovae?

13 OUTREACH AND PUBLIC RELATIONS

The Kavli IPMU continues to convey the importance and pleasure of our research on physics and mathematics of the universe to the general public through a variety of outreach programs.

April :
- Quimby's Team Found a Lens Galaxy Magnifying a Type Ia Supernova
- Freeman Dyson visit Kavli IPMU
- The 10th ICRR-Kavli IPMU Joint Public Lecture
- Evening of Art and Live Music in Piazza Fujiwara

June :
- 7th Meeting of the Kavli IPMU External Advisory Committee
- Science Café Universe 2014

Aug :
- A Program to encourage Female Students to Study Science
- Charles Melby-Thompson talked at the Super Science High School Students Fair 2014

Sep :
- Lurking Bright Blue Star Caught! —The Last Piece of a Supernova Puzzle
- Joint Public Lecture with ISSP

Oct :
- NSF Director France Córdova Visited the Kavli IPMU
- Director Murayama Delivered a Speech at the UN Headquarters
- Kashiwa Campus Open House 2014

Nov :
- Kavli IPMU held "Science Onsen (Spa)" in Science Agora 2014
- The 11th Kavli IPMU-ICRR Joint Public Lecture

Dec :
- The Fourth annual WPI joint symposium
- Santa Claus is coming to Donguri from the Kavli IPMU

Feb :
- WPI institutes jointly participated in AAAS 2015 in San Jose, California

Mar :
- Spring science camp for high school students held at the Kavli IPMU
- Public Lecture on Recent Supernovae Research

Quimby's Team Found a Lens Galaxy Magnifying a Type Ia Supernova

A supernova is a tremendously luminous object caused by a stellar explosion. Among various types of supernovae, those classified as type Ia (SNIa) have strikingly similar peak luminosities, and this property allows astronomers to use SNIa as standard candles to measure cosmological distance. However, PS1-10afx, a supernova observed at a distance of about 9 billion light years from the Earth was much more luminous than the normal SNIa, though it showed other properties almost identical to those of SNIa. So, this was a big puzzle.

As reported in the June 2013 issue of the *Kavli IPMU News* (see No. 22, page 33), a team of researchers at the Kavli IPMU including Robert Quimby and Marcus Werner published the argument that PS1-10afx is a type Ia supernova 30 times magnified by a strong gravitational lens effect due to a massive galaxy (lens galaxy) existing in front of the PS1-10afx; the lens galaxy warps space-time to form magnified images of the supernova.

Press conference at the Sanjo Conference Hall

A question remained as where the lens galaxy is located, however, because, observed from the Earth, the lens galaxy overlaps with the host galaxy wherein the supernova appeared; the existing data do not allow us to separate the signal of the foreground lens galaxy from that of the host galaxy.

In September 2013, when the PS1-10afx sufficiently faded away, Quimby's team successfully extracted the light signal of the foreground galaxy in the glare of the relatively bright host galaxy, using the Low-Resolution Imaging Spectrograph on the Keck-I telescope located in Hawaii. This result confirmed the existence of the lens galaxy, which causes the lensing, between the host galaxy and us. The team reported this result in *Science*, a famous academic journal published by the American Association for the Advancement of Science (AAAS), on April 25, 2014. At the same time, Quimby's team held a press conference at the University of Tokyo's Sanjo Conference Hall on the Hongo campus. The AAAS/Science side moderated the conference. The news was covered widely in the media internationally.

Freeman Dyson Visited Kavli IPMU

On April 15-19, 2014, Freeman Dyson visited the Kavli IPMU. He is a Professor Emeritus of the Institute for Advanced Study, famous for his outstanding achievements in various scientific fields, in particular, quantum electrodynamics. He is just over 90 years of age, and he is still actively engaged in science. Then, he visited the Kamioka Observatory of the Institute for Cosmic Ray Research / the Kamioka Branch of the Kavli IPMU on April 21-22, and in particular, Super-Kamiokande and other underground experiments.

You can find an interview (including a summary of the Q&A session) with him by Kavli IPMU Professor Masataka Fukugita. (See *Kavli IPMU News* No. 26, pp. 22-30.)

Freeman Dyson giving a lecture

10th ICRR-Kavli IPMU Joint Public Lecture "Decoding the Mystery of the Universe"

On April 12, 2014, the 10th ICRR (Institute for Cosmic Ray Research, The University of Tokyo)-Kavli IPMU joint public lecture, entitled "Decoding the Mystery of the Universe," was held at Amuser Kashiwa, which is located near the JR Kashiwa station.

The first lecture was given by Toshitake Kohno, Professor at the Graduate School of Mathematical Sciences, the University of Tokyo and Kavli IPMU Principal Investigator, on "The Shape of the Universe ~ Mathematical Challenges." He talked about proposing models of the "shape of the Universe," which are in agreement with the observational data, using mathematics. Next, Vice-Director of ICRR, Professor Toshio Terasawa, gave a talk entitled "Shocking Universe ~ Universe Is Full of Shock Waves." He talked about the roles which strong shock waves, produced by explosive phenomena in the Universe, such as solar flares, supernovae, gamma-ray bursts, etc., play in the Universe.

Toshitake Kohno giving a lecture

Evening of Art and Live Music in Piazza Fujiwara

On April 25, two social groups of Kavli IPMU researchers and staff, the IPMU Chamber Orchestra and the Arts Society for the first time cohosted the *IPMUsic+arts night*. On the 3rd floor of the Kavli IPMU Building, in front of the wall of the Piazza Fujiwara, on which 35 pictures contributed from Kavli IPMU researchers and staff with the theme, "Repetition, Scale, Duration" were exhibited, as many as 10 programs of musical performance, including the IPMU Chamber Orchestra's performance, and piano solo, *koto* (traditional Japanese stringed musical instrument), *karaoke*, and singing and playing guitar, were presented by researchers and staff for 3 hours including a break. In Piazza Fujiwara, a great many researchers, staff, and their families and friends gathered, and they enjoyed the *IPMUsic+arts night*, with wine and snacks contributed by Administrative Director Haruyama and others. There were many vivid conversations among the participants, irrespective of their positions, nationalities, and research fields, on, for instance, art, and music skills that are unexpected from their everyday life.

IPMUsic+arts night in Piazza Fujiwara

7th Meeting of the Kavli IPMU External Advisory Committee

On June 30, 2014, the seventh meeting of the Kavli IPMU External Advisory Committee was held with the attendance of all the committee members. This time, with the submission deadline approaching about a half month ahead of the proposal for a five-year extension of the WPI funding after the initial ten years of support, the Committee gave many valuable suggestions for the content of the proposal and related issues.

Committee members: far side, from left to right, Nigel Smith (SNOLAB), John Ellis (King's College London), Steve Kahn (Chair, Stanford Univ./SLAC), David Morrison (UC Santa Barbara), Sadanoti Okamura (Hosei Univ.), Young-Kee Kim (Chicago Univ.), and Sadayoshi Kojima (Tokyo Tech)

Science Café Universe 2014

Satoshi Kondo answering questions after the lecture

Katsuhiko Sato answering questions after the lecture

The annual "Science Café Universe 2014" was held at the Tamarokuto Science Center (TSC) in Nishi-Tokyo City, jointly sponsored by the Kavli IPMU and the TSC. This year, Kavli IPMU Assistant Professor in mathematics Satoshi Kondo gave the first lecture entitled, "Number Theory: A Story of Prime Numbers," on June 21, and President of the National Institutes of Natural Sciences (NINS) Katsuhiko Sato, who is also a Kavli IPMU Senior Scientist, gave the second lecture entitled "Inflation Theory: Expectation of Its Observational Evidence," on July 6.

Since 2012, a Science Café lecture given on July 7, the Star Festival (Tanabata), or on the day before it, has been customarily delivered in the evening at a special venue, the TSC's planetarium dome which is known as the "Science Egg," with a Q&A session held in the TSC's café corner after the lecture. As Professor Sato is one of those scientists who proposed the inflation theory of the universe, he particularly talked about the newest picture of the universe, which might be brought about by the "discovery" of primordial gravitational waves predicted by the inflation theory. This "discovery" was reported in March of this year from an experiment measuring the polarization of the cosmic microwave background at the South Pole. It became big news, but it has yet to be confirmed. (See *Kavli IPMU News* No. 26, p. 38.)

A Program to Encourage Female Students to Study Science: "Listen to and Look into the Universe"

On August 2, 2014, a Program to Encourage Female Students to Study Science: "Listen to and Look into the Universe," was held at the Kavli IPMU, jointly hosted by the Kavli IPMU and the Institute for Cosmic Ray Research (ICRR) of the University of Tokyo. The program started from two lectures by female researchers working on leading edge research of the Universe. One of the lectures was given by Tomoko Iwashita, a support scientist at the Kavli IPMU. She spoke on "Where Did Antimatter Go? —Elucidating the Mystery of the Universe Using Accelerators—" In her talk, she explained research conducted at the High Energy Accelerator Research Organization (KEK) at Tsukuba. Another lecture was given by Naoko Ooishi, an Assistant Professor at the ICRR, on "The Music Played by Astronomical Objects." She explained what the gravitational wave is, and then talked about an experiment conducted at the ICRR attempting to directly detect gravitational waves produced by astronomical phenomena. After the lectures, the participants visited a laboratory where they watched fabrication of a vertex detector with which particle tracks will be measured within a few μm levels of precision. They then learned the principle of the gravitational-wave detector and assembled a tabletop laser interferometer. Finally, they enjoyed friendly conversation with lecturers and graduate students who helped as teaching assistants, about campus life, research, and the like.

Female students talking with lecturers and graduate students

Charles Melby-Thompson Talked at the SSH Students Fair 2014

Charles Melby-Thompson talking to SSH students

On August 6 and 7, 2014, the Super Science High School Students Fair 2014 was held at Pacifico Yokohama. In this event, the nine WPI centers, including the Kavli IPMU, jointly ran a booth exhibiting their research activities. In one of the programs, entitled "Researchers Mini Live," 17 researchers gave mini lectures. Five of them were from the WPI centers; from the Kavli IPMU, postdoc Charles Melby-Thompson enthusiastically talked on, "Watching the Unseen through the Lens of Reason," in English. His lecture to a full audience was well received, and after the lecture he was asked a lot of questions, such as, "What is the nature of dark matter?" and, "What is the significance of experiencing study in a foreign country?"

Joint Public Lecture with ISSP "Close Connection between Materials Science and Particle Physics"

A scene of Hiroshi Ooguri's lecture

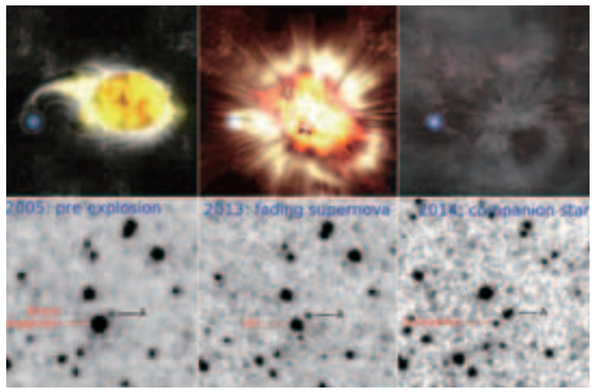
On September 28, 2014, a joint public lecture, "Close Connection between Materials Science and Particle Physics" was held at the Kashiwanoha Conference Center, which is located in front of the TX Kashiwanoha campus station. It was hosted by the Institute for Solid State Physics (ISSP) of the University of Tokyo, and cohosted by the Kavli IPMU and Kashiwa City. Two lectures were given: "One-Dimensional Materials and String Theory," by Professor Masaki Oshikawa of ISSP, and "Is the Universe Superconducting?" by Kavli IPMU Principal Investigator Hirosi Ooguri. In these lectures, they explained the close connection between materials science and particle physics in an easy-to-understand manner. They also introduced leading edge research that emerged from collaboration among researchers from both fields.

Lurking Bright Blue Star Caught! —The Last Piece of a Supernova Puzzle

A team led by Gastón Folatelli at the Kavli IPMU, the University of Tokyo, has found evidence of a blue star, which is luminous in the near ultraviolet region at the site of supernova SN 2011dh, which occurred in 2011 in the nearby galaxy M51.

SN 2011dh has been known to be a type II supernova, which is the explosion of a massive star due to gravitational collapse at the end of its life. In the images obtained before the explosion, however, a yellow supergiant (YSG) star was detected at the location of the supernova. But YSG stars in isolation were not thought capable of becoming supernovae and controversy arose in the astronomy community. Some researchers claimed that the actual progenitor must have been a blue compact object called the Wolf-Rayet star; it was faint enough in the optical range so that it was not detected in the pre-supernova images of the space telescope and the detected YSG star could have been a companion of the exploded star, or even an unrelated object that matched the projected supernova location by chance.

In 2012, the team led by Melina Bersten at the Kavli IPMU and Omar Benvenuto at the University of La Plata, Argentina, showed that the exploding star must have been extended, like a yellow supergiant, and that it must have belonged to a binary system. They predicted that, once the supernova has faded enough, the companion could be discovered in the blue range of the spectrum. In March 2013, the HST imaging observational result, which showed the disappearance of the YSG star was announced, and the prediction by the Bersten group was partly confirmed. This time, the observation of a bright blue star at the location of SN 2011dh conclusively confirmed the binary model they proposed. This result has been published in *Astrophysical Journal Letters* **793** (2014) L22. Also, a press conference was held on September 11, 2014, and it has provoked worldwide public response.



Images in the top row depict an artist's conception of the supernova explosion process. The corresponding images below were taken with the Hubble Space Telescope. The middle top image shows the supernova exploding and the middle bottom image shows the fading supernova after the explosion. (©Top image: Kavli IPMU, Bottom image: NASA, Hubble)

NSF Director France Córdova Visited the Kavli IPMU

From left to right: Dr. France Córdova, Kavli IPMU postdoctoral fellows, Claire Lackner and Edmond Cheung, and Hitoshi Murayama, discussing at tea time

On October 3, 2014, Dr. France Córdova, Director of the National Science Foundation (NSF) visited the Kavli IPMU in the company of Dr. Graham Harrison, Program Manager, Office of International and Integrative Activities, NSF, and Dr. Kellina Craig-Henderson, Director, NSF Tokyo Regional Office. They heard Kavli IPMU Director Hitoshi Murayama's presentation of the research activities at the Kavli IPMU including past experience of accepting researchers supported by NSF grants, and exchanged frank opinions with Director Murayama regarding the support to basic science.

Subsequently, the guests joined the tea time held in the Piazza Fujiwara and enjoyed the interactions with young researchers from many countries. In particular, Dr. Córdova, talked with female astronomers to share her own scientific contributions in the areas of observational and experimental astrophysics.

Director Murayama Delivered a Speech at the UN Headquarters

CERN was established in 1954. In 2014, it has been celebrating its 60th anniversary with a series of events, and the celebrations have been brought to a close with a special high-level event at the United Nations Headquarters in New York, on October 20: "CERN: Sixty Years of Science for Peace and Development," organized by CERN and the United Nations Economic and Social Council (ECOSOC). In this event, Kavli IPMU Director Hitoshi Murayama has delivered a keynote speech entitled, "Science for peace and development today and tomorrow." The program also included the speeches of UN Secretary-General Ban Ki-moon and CERN Director-General Rolf Heuer, and the keynote speeches of Nobel Physics Prize Laureate and former CERN Director-General Carlo Rubbia, Nobel Peace Prize Laureate and former UN Secretary-General Kofi Annan.
For Murayama's key note speech, see *Kavli IPMU News* No. 28, pp. 4-6.

Kashiwa Campus Open House 2014

An open house on the Kashiwa campus of the University of Tokyo was held on October 24 (Friday) and 25 (Saturday), 2014. In two days, the entire Kashiwa campus was visited by about 8,000 people, and the Kavli IPMU attracted about 2,000 people.
The Kavli IPMU's program included two public lectures by Professor Masashi Hazumi and by Director Hitoshi Murayama, introductory poster presentations of the research conducted at the Institute, math puzzles, 3D movie program "Story of the Origin of the Universe," guided building tours, and Science *Onsen* (Spa). (For Science *Onsen, see* the next news item.)

At a seminar room, graduate students explained poster presentations of the research conducted at the Kavli IPMU as well as math puzzles

Prof. M. Hazumi talked on "Probing the Origin of the Universe — Towards the LiteBIRD Satellite"

Director Murayama gave a lecture entitled, "Together with Chiba-kun (a mascot character of Chiba prefecture), Listen to Professor Murayama about the Story of the Universe"

Kavli IPMU Held "Science *Onsen* (Spa)" in Science Agora 2014

"Science Agora" is an annual event, aimed at building good relations between Science and the future Society. Its program includes science experiments for children, talking with top scientists, science discussion with public participation — they are open to anyone who wants to participate. On November 7-9, 2014, Science Agora 2014 was held in the Tokyo waterfront region of Odaiba, and the Kavli IPMU participated on November 9 by holding "Science *Onsen* (Spa) — Science and Art, Do They Actually Share Things Similar?!" at the Miraikan Hall, on the 7th floor of the National Museum of Engaging Science and Innovation (*Miraikan*).

A scene of Science Onsen in Science Agora 2014

What is Science Onsen? Adapting from Science Café, which is believed to have started in England, Science *Onsen* aims at discussion between scientists and people in a relaxing mood in an *onsen* (spa), which is very popular in Japan. Actually, such a relaxing mood may be created by participants wearing towels around their necks, and in particular, speakers and facilitators wearing yukata (an informal cotton kimono for summer wear), as if they were bathing in a real *onsen*.
At this Kavli IPMU's Science Onsen, a contemporary artist (painter) Mr. Yusuke Asai and an Assistant Professor at the Kavli IPMU Masahito Yamazaki, both wearing yukata, had a sincere talk on a serious subject, "The Method to Approach the Object." An audience of about 30 listened to their talk in a relaxing mood, wearing Kavli IPMU original *onsen* towel around their necks. The audience looked impressed by having witnessed how they approach certain aspects of their complex worlds, and the similarities of their methods. After the talk, there were a lot of questions from the audience until the time ran out.

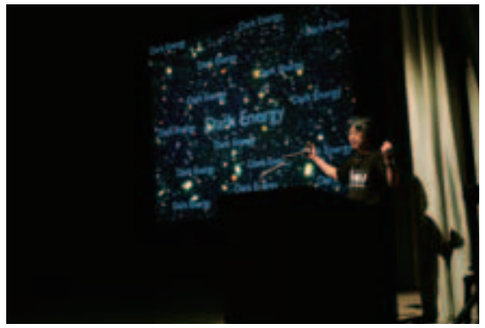
The 11th Kavli IPMU-ICRR Joint Public Lecture — Look into the Universe

Professor Yamashita (left) and Professor Matsumoto (right)

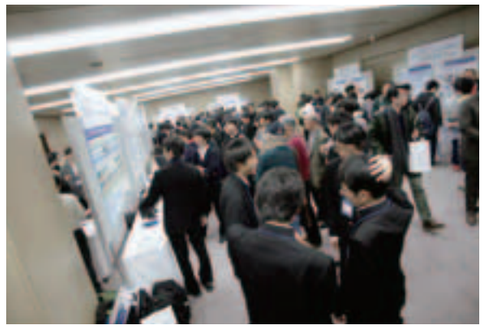
On November 15, 2014, the Eleventh Kavli IPMU-ICRR (Institute for Cosmic Ray Research) joint public lecture, "Look into the Universe—Approaching the Nature of Dark Matter—," was held at the West Lecture Hall of the 21 Komaba Center for Educational Excellence (KOMCEE) on the University of Tokyo's Komaba campus with audience of about 200 people. The first lecture entitled, "On the Nature of Dark Matter," was a review of the present investigations of dark matter, given by a theoretical physicist Shigeki Matsumoto, a Kavli IPMU Associate Professor. The second lecture, "Underground Search for Dark Matter," was given by an experimental physicist Masaki Yamashita, an ICRR Associate Professor and a Kavli IPMU Scientist. He is a member of XMASS, an underground experiment in search for dark-matter. After the lectures, the two lecturers presented their frank conversation about "How Interesting Is Dark Matter?" The audience also enjoyed teatime surrounding the lecturers.

The Fourth Annual WPI Joint Symposium Held in Tokyo

The Fourth Annual WPI Joint Symposium has been held on December 13, 2014 at the Yurakucho Asahi Hall in Tokyo, hosted by Kavli IPMU and co-hosted by the other eight WPI centers. The main purpose of this series of joint symposia is to attract, in particular, high school students to leading-edge scientific research.
The Symposium was opened by speeches by Junichi Hamada, President of the University of Tokyo, and Yutaka Tokiwa, Director-General of Research Promotion Bureau, MEXT. Subsequently, there was a presentation of video recording in which a young researcher from each of the nine WPI centers features his/her research. Lectures were then given by three top-level researchers from WPI centers. Kavli IPMU Director Hitoshi Murayama was among them, giving a talk on "Is There an End to the Universe?" Some high school students also presented their research results. In addition, there were poster presentations of researches at the WPI centers and those of high school students on their daily research activities.



Lecture by Kavli IPMU Director Hitoshi Murayama


Exhibition room for poster presentations

Santa Claus Is Coming to Donguri from the Kavli IPMU

Every year, near Christmas, Kavli IPMU Professor Mark Vagins visits Donguri Nursery School on the Kashiwa campus, dressed up as Santa Claus. This year, Professor Vagins has visited Donguri with his wife and his son, and they had a joyful time with children in Donguri.


Professor Mark Vagins and his family with staff of Donguri

WPI Institutes Jointly Participated in AAAS 2015 in San Jose, California

All nine WPI institutes jointly participated again this year in the 2015 AAAS (American Association for the Advancement of Science) Annual Meeting held for five days, February 12-16, 2015, in San Jose, California, with a theme of "Innovations, Information, and Imaging." Similar to last year's participation in Chicago, the WPI institutes for three days jointly ran the WPI booth, where each institute displayed a panel poster and brochures. At the WPI booth, MEXT (the Ministry of Education, Culture, Sports, Science and Technology) and JSPS (Japan Society for the Promotion of Science) officers in charge of the WPI program as well as officers from eight WPI institutes including the Kavli IPMU welcomed visitors and explained to them the WPI program and the research activities and outcomes of the WPI institutes. In three days, nearly 400 people visited the WPI booth.
To date, the Kavli IPMU has joined AAAS Annual Meetings for four consecutive years from 2012, sending a few officers each time. The next AAAS Annual Meeting will be held in February 2016 in Washington, D.C.

Spring Science Camp for High School Students Held at the Kavli IPMU

For three days, March 25-27, 2015, "Spring Science Camp 2015: A Challenge to Unravel the Mystery of the Universe through Astronomy, Physics, and Mathematics" was held at the Kavli IPMU.
The Spring Science Camp 2015 is one of the projects supported by JST (Japan Science and Technology Agency) for next-generation S&T human resource development, providing hands-on experience for high school students. The three-day camp during spring break was held at 12 different host universities and private companies where cutting-edge research is conducted in a variety of fields. Each host provided a different program and accommodated 8 to 20 students (168 students in total). Students were directly guided by scientists and engineers working at the frontiers of S&T.
The participants in the Kavli IPMU program were 10 male and 10 female students selected from a highly competitive field of applicants from all over Japan. They learned cutting-edge research on unraveling the mystery of the Universe through lectures as well as exercises and an experiment by Kavli IPMU researchers in physics, mathematics, and astronomy. In the evening after classroom learning, the students were given plenty of time to ask questions and to interact with lecturers and teaching assistants (undergraduate and graduate students). There were continued conversations with lecturers and teaching assistants on what students wanted to ask more regarding the lectures and exercises. Students also asked them about such topics as the life of university students and the life of researchers. In the afternoons, students joined the Kavli IPMU's everyday tea time and enjoyed chats with both Japanese and foreign researchers. On the last day, students presented what they had learned in the camp, and were given a certificate of completion.


Kavli IPMU Professor Masahiro Takada giving a lecture


A scene of astronomy exercises

Public Lecture on Recent Supernovae Research

On Sunday, March 29, 2015, the Kavli IPMU held a public lecture on recent supernovae research at the Yayoi Auditorium, Ichijo Hall on the University of Tokyo's Hongo campus. There were about 200 people in the audience. Supernovae research is important in understanding the evolution of galaxies and the history of the expansion of the Universe, and it is one of the main research topics at the Kavli IPMU. At the public lecture, Kavli IPMU Principal Investigator, Professor Ken'ichi Nomoto, explained "What are supernovae?," Kavli IPMU Professor Mark Vagins discussed how to observe "Neutrinos from Supernova Explosions" in English with simultaneous interpretation into Japanese, and Kavli IPMU Assistant Professor Nao Suzuki spoke on the "Dark Energy Discovery Story." After the lecture, there was a tea break with the three lecturers, who answered a great number of questions asked by the audience.

Kavli IPMU Principal Investigator Ken'ichi Nomoto giving a lecture

Kavli IPMU Professor Mark Vagins giving a lecture

Kavli IPMU Assistant Professor Nao Suzuki answering questions

Kavli IPMU News

Four issues of the Kavli IPMU News have been published in FY 2014.




Ask a Scientist

A series of "Ask a Scientist" video clips is shown to the public on the Kavli IPMU website and YouTube. Kavli IPMU researchers explain scientific terms related to the research program at the Kavli IPMU in a few minutes. Two new clips were released in FY2014

Approach to "field theory" from string theory
Masato Yamazaki

Cosmic Microwave Background
Haruki Nishino

Kavli Institute for the Physics and Mathematics of the Universe (Kavli IPMU)
The University of Tokyo Institutes for Advanced Study
The University of Tokyo

5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8583, Japan TEL: +81-4-7136-4940 FAX: +81-4-7136-4941 http://www.ipmu.jp/

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