HitoshiFest

Our collaboration

KAVLI IPMU in the puberty period

KAVLI IPMU Renaissance

KAVLI IPMU to expand into U.Tokyo

KAVLI IPMU to expand into the World

KAVLI IPMU to expand into Japan

KAVLI IPMU as a Gateway to the World

Toward the future

As I wrote in November issue of our Newsletter, I had long believed that inflationary cosmology, or particle cosmology, would never have anything to do with observation in the future.

So, I decided to take the liberty of thinking that if I could explain three things at once with one input, it would be alright, and I actualy did that, which made me happy.

This was my own guiding principle, or capturing three birds with one stone.


November 2024 www.ipmu.jp press@ipmu.jp

Kavli IPMU Newsletter

©Yukari Ito

©Tom

FROM THE DIRECTOR

On the occasion of the 17th anniversary

Unveiling the early universe using cutting-edge particle physics theory - what a wonderful research topic! When I entered graduate school in the 1980s, there were no clues because it was inconceivable that such an early universe could be determined by experiment or observation. So, I decided to take the liberty of thinking that if I could explain three things at once with one input, it would be alright, and I actually did that, which made me happy. Later, when I read in a paper that linked the spectral index of density fluctuations to the potential of a field to cause inflation, and this was to be determined by observation, I thought what nonsense. Of course, however, it was nonsense on my part, and this is what has led to the rise of observational cosmology of the early universe today. But it no longer captures my imagination as much as it used to.

Turning to particle physics, all the latest accelerator experiments have confirmed the correctness of the Standard Model but have not even provided a clue to physics beyond it. In other words, the current state of particle physics is exactly like cosmology when I was a student. This is precisely the golden age in which theorists can develop their ideas without being bound by anything. We know that particle physics does not end with the Standard Model because it does not explain dark matter, neutrino mass, and the origin of matter. There is no better place to solve that mystery than at Kavli IPMU, where mathematicians, cosmologists, experimentalists, and astronomers are also present. Let us meet at teatime and unravel the mysteries of the Universe!

Director Jun'ichi Yokoyama

PERSONNEL CHANGES

Employed - welcome to Kavli IPMU

- 16 November Vaibhav Gautam, Project Researcher

NOTE: Information from November 1 to November 30, 2024

SCHEDULE OF EVENTS

NOVEMBER

November 6 - November 8
Conference
"T2K analysis workshop"
Organizer: Cesar Valls, Mark Vagins
Venue: Kavli IPMU Lecture Hall

November 13 - November 15
Conference
"Focus week on primordial black holes 2024"
Organizer: Misao Sasaki, Alexander Kusenko
Venue: Kavli IPMU Lecture Hall

November 18 - November 21
Conference
"Probing the Genesis of Supermassive Black Holes: Emerging Perspectives from JWST and Expectation toward New Wide-Field Survey Observations"

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So, I decided to take the liberty of thinking that if I could explain three things at once with one input, it would be alright, and I actually did that, which made me happy.

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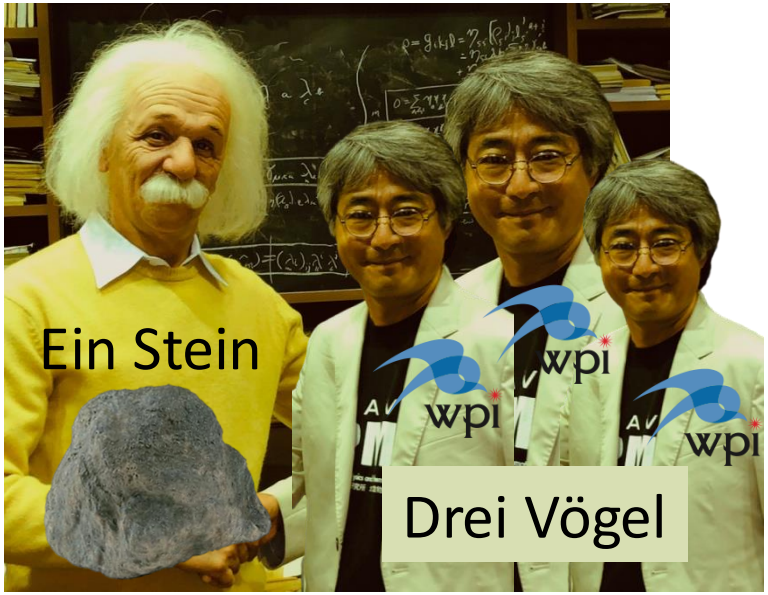

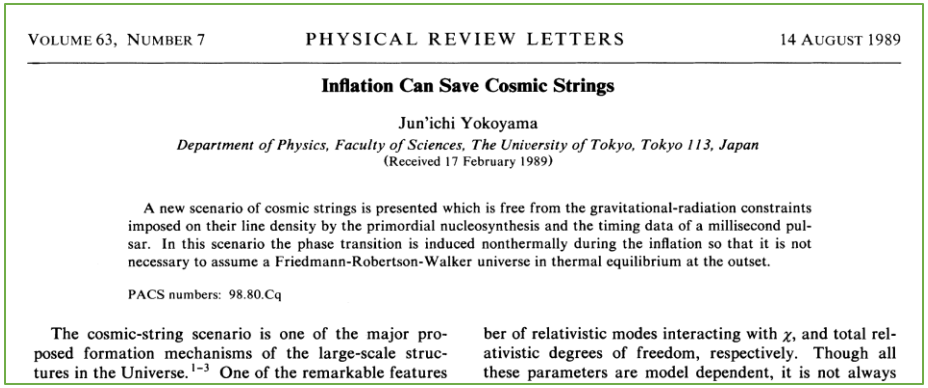

VOLUME 63, NUMBER 7 PHYSICAL REVIEW LETTERS 14 AUGUST 1989

Inflation Can Save Cosmic Strings

Jun'ichi Yokoyama

Department of Physics, Faculty of Sciences, The University of Tokyo, Tokyo 113, Japan

(Received 17 February 1989)

A new scenario of cosmic strings is presented which is free from the gravitational-radiation constraints imposed on their line density by the primordial nucleosynthesis and the timing data of a millisecond pulsar. In this scenario the phase transition is induced nonthermally during the inflation so that it is not necessary to assume a Friedmann-Robertson-Walker universe in thermal equilibrium at the outset.

PACS numbers: 98.80.Cq

The cosmic-string scenario is one of the major proposed formation mechanisms of the large-scale structures in the Universe.[1-3] One of the remarkable features

ber of relativistic modes interacting with χ, and total relativistic degrees of freedom, respectively. Though all these parameters are model dependent, it is not always

$$V_c[\chi] = (\lambda/4)(|\chi|^2 - v^2)^2 + \tfrac{1}{12}\mathcal{R}|\chi|^2, \quad U[\phi] = \tfrac{1}{2}m^2\phi^2$$

This single input (one stone=ein Stein) solves 3 problems.

- thermal phase transition unnecessary
- Inflation does not dilute strings
- GW background consistent w/ PTA

Fukugita-san said to me: "Your recent paper is bizarre. You are trying to save something that does not exist with something that does not exist."

I have two papers with Hitoshi 31 years ago…

VOLUME 70, NUMBER 13 PHYSICAL REVIEW LETTERS 29 MARCH 1993

Chaotic Inflation and Baryogenesis by Right-Handed Sneutrinos

H. Murayama, Hiroshi Suzuki, and T. Yanagida
Department of Physics, Tohoku University, Sendai 980, Japan

Jun'ichi Yokoyama
Uji Research Center, Yukawa Institute for Theoretical Physics, Kyoto University, Uji 611, Japan
(Received 23 November 1992)

We present a model of chaotic inflation driven by the superpartner of the right-handed neutrino ($\tilde{N}_R$). This model gives the correct magnitude of the density perturbation observed by the Cosmic Background Explorer satellite with a right-handed neutrino mass $\simeq 10^{13}$ GeV, which is also preferred by the Mikheyev-Smirnov-Wolfenstein solution to the solar neutrino problem. The reheating process is the decay of the coherently oscillating $\tilde{N}_R$. This decay process also generates lepton asymmetry via CP violation, which will be converted to baryon asymmetry thanks to the electroweak anomaly. This model can incorporate the τ-neutrino mass $\simeq 10$ eV.

RAPID COMMUNICATIONS

PHYSICAL REVIEW D VOLUME 50, NUMBER 4 15 AUGUST 1994

Chaotic inflation and baryogenesis in supergravity

Hitoshi Murayama*
Theoretical Physics Group, Lawrence Berkeley Laboratory, University of California, Berkeley, California 94720

Hiroshi Suzuki†
Instituto Nazionale di Fisica Nucleare, Sezione di Genova, 16146 Genova, Italy

T. Yanagida
Department of Physics, Tohoku University, Sendai, 980, Japan

Jun'ichi Yokoyama
Uji Research Center, Yukawa Institute for Theoretical Physics, Kyoto University, Uji, 611 Japan
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PACS numbers: 98

SUSY (LEP experiment)
Right-handed heavy Ma

- Inflation
- Reheating
- Baryogenesis
- Mixed dark m

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PACS numbers: 98.80.Cq, 05.45.+b, 14.60.Gh, 14.80.Ly

Although highly successful, an obvious drawback of this model was the fact that it waws based on global SUSY.
We therefore began our research to realize it in Supergravity.

Inflation in Supergravity

Model building = Specify Kähler potential K, and Superpotential W

From $G \equiv K + \ln |W|^2$ the Lagrangian of the inflaton is given by

$$\mathscr{L}_\varphi = G^j_i \partial_\mu \partial^\mu \varphi^*_j - e^G [G_i (G^i_j)^{-1} G^j - 3], \qquad (1)$$

where $G_i = \partial G / \partial \varphi^i$, $G^j = \partial G / \partial \varphi^*_j$, and we have taken units with $M_{\rm Pl}/\sqrt{8\pi} = 1$. In the "minimal" supergravity, to ensure canonical kinetic terms for φ^i, one takes the Kähler potential as $G[\varphi, \varphi^*] = \varphi^i \varphi^*_i + \ln |W[\varphi]|^2$, where $W[\varphi]$ is a superpotential. Then the scalar potential has an exponential factor $e^{\varphi^*_i \varphi^i}$ which makes it very difficult to incorporate chaotic inflation.

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$$1 + \frac{\varphi^*_i \varphi^i}{M_G^2} + .. \quad \times \quad V \quad \Rightarrow H^2 \varphi^*_i \varphi^i$$

Too large induced mass
now known as the η problem

Inflation in Supergravity

RAPID COMMUNICATIONS

PHYSICAL REVIEW D VOLUME 50, NUMBER 4 15 AUGUST 1994

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Uji Research Center, Yukawa Institute for Theoretical Physics, Kyoto Unive

(Received 15 March 1994)

We propose a Kähler potential in supergravity which successfully accommod
model can have a large gravitino mass without giving a large mass to squarks an
from both the gravitino problem and entropy crisis. In this model baryogenesis ta
fying the inflaton with a right-handed sneutrino with its mass $M \simeq 10^{13}$ GeV, w
COBE data and the Mikheyev-Smirnov-Wolfenstein solution to the solar neutrino p
accommodate the matter content appropriate for the mixed dark matter scenario.

PACS number(s): 98.80.Cq, 04.65.+e, 14.80.Ly

Now we propose the following Kähler potential free from such difficulties,

$$G=\frac{3}{8}\ln\eta+\eta^2+\ln|W(\varphi)|^2, \tag{2}$$

$$\eta=z+z^*+\varphi_i^*\varphi^i, \quad W=\frac{1}{2}M\phi^2 \tag{3}$$

where φ^i denotes chiral fields in the model. Then the scalar Lagrangian is given by [14] (see Appendix for derivation)

$$\mathscr{L}=\frac{16\eta^2-3}{32\eta^2}[(\partial_\mu\eta)^2+(I_\mu)^2]+\frac{16\eta^2+3}{8\eta}|\partial_\mu\varphi^i|^2-V, \tag{4}$$

with the potential

$$V=\eta^{3/8}e^{\eta^2}\left\{\frac{8\eta}{16\eta^2+3}|W_i|^2+\frac{(16\eta^2-9)^2}{8(16\eta^2-3)}|W|^2\right\}+D \text{ terms} \tag{5}$$

where $W_i=\partial W/\partial\varphi^i$, and I_μ is a U(1) current defined by $I_\mu=i\partial_\mu(z-z^*)+i(\varphi^i\partial_\mu\varphi_i^*-\varphi_i^*\partial_\mu\varphi^i)$. Note that gauge singlet fields do not contribute to D terms.

Hitoshi reached a solution, which was rather contrived making use of non-renormalizable terms of Supergravity.

I lost interest in such model building in Supergravity as it has uncontrolably many degrees of freedom.

IPMU INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE

was founded in October 2007 by Hitoshi Murayama truly out of scratch.

For making so many decisions from nothing at all and developing it to what it is today, I would like to express my sincere respect.

KAVLI IPMU INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE

has now entered adolescence after puberty period toward adulthood.

Our situation and environmental situation are quite different from it used to be.

KAVLI IPMU in the puberty period

stagnation?

rebellious age?

In a few years leading up to my arrival, various indicators showed a decline, and as the institute's new director, I knew I had to improve the situation.

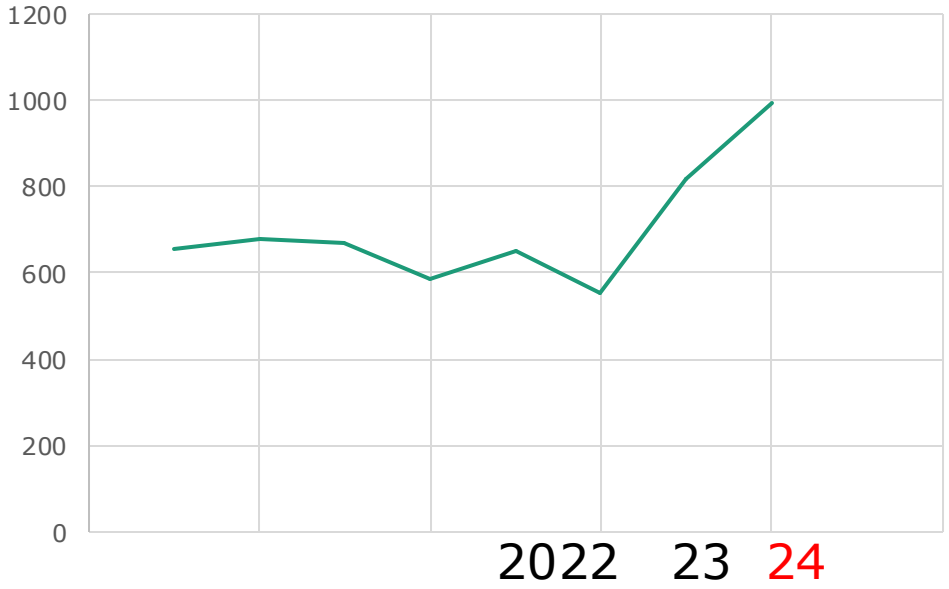
- Postdoc recruitment

  For a long time, the number of applicants had been almost constant around 660 except for 2020 due to Covid. However, in 2022 the number decreased to 555, and I had a strong fear to end up with even larger decline in 2023, reflecting significant devaluation of Japanese Yen.

Countermeasures

- Contacted past visitors as much as possible to ask them to recommend the position here to relevant people, because they know the atmosphere of IPMU and living cost in Japan.
- We advertised the opening where we had not done so before.

555→818→>953



KAVLI IPMU in the puberty period

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In a few years leading up to my arrival, various indicators showed a decline, and as the institute's new director, I knew I had to improve the situation.

- Kakenhi Grant

  Amount declining. Acceptance rate fluctuating. Not everyone who was eligible to apply had applied.

Countermeasures

- Encouraged everyone to apply.
- Information sessions were held, and enhanced support team.

Number of application has increased to 52 this year from 36 last year.
Acceptance rate of startup kakenhi also improved significantly.

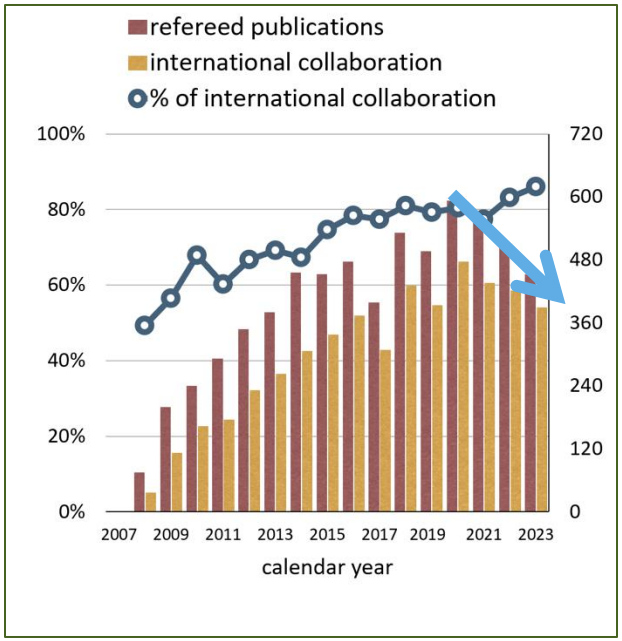
KAVLI IPMU in the puberty period

stagnation?

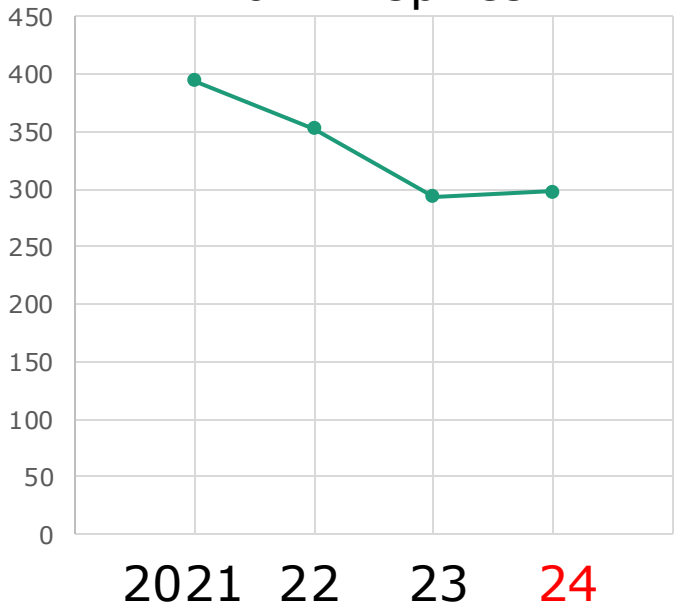
rebellious age?

In a few years leading up to my arrival, various indicators showed a decline, and as the institute's new director, I knew I had to improve the situation.

- Publication record
  Linearly declining!?



from Inspires

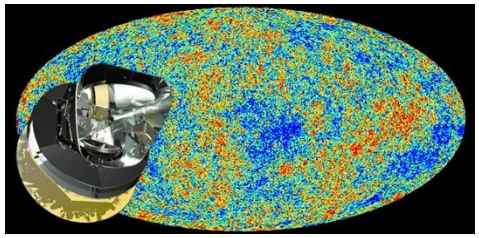


Countermeasures

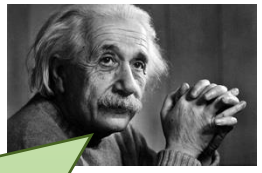
- Encouraging free and vigorous discussion, and all members meet at teatime!
- Ensure each experimental group maintains critical mass.
- Affiliate members are playing important roles. Started Kavli IPMU Newsletter for them. Introduced a new visitor travel expense rule.

Going back to the science of inflation

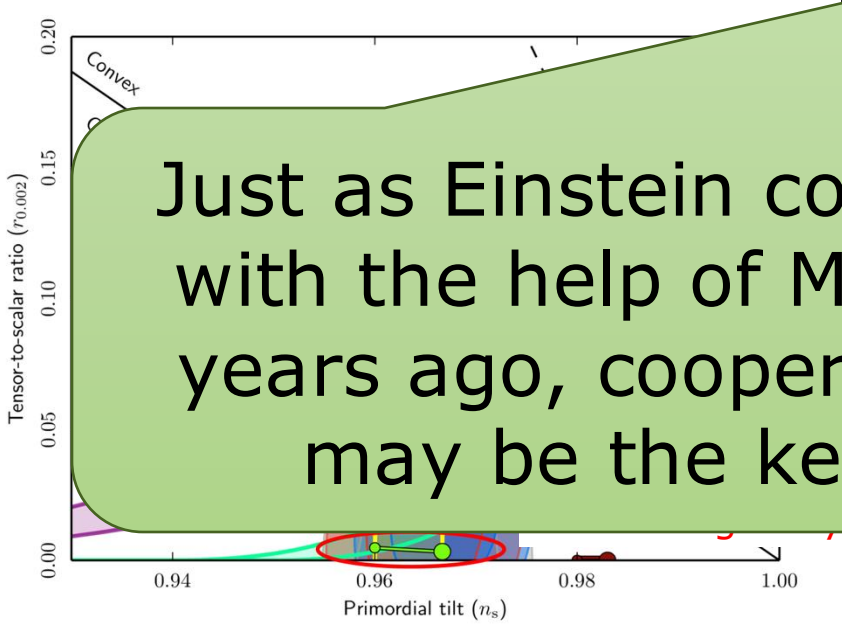
For a long time, we thought Supersymmetry was a mandatory ingredient in inflationary cosmology to stabilize a tiny coupling constant $\lambda \approx 10^{-13}$ required to suppress density/curvature fluctuations to $\approx 10^{-5}$.



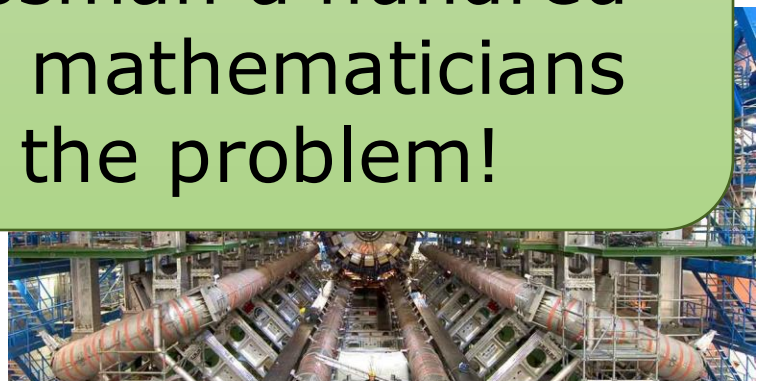
CMB observations favor models based on Modified Gravity rather than those based on SUSY in Einstein Gravity. These preferred models have large parameters whose origin is unknown.



must be modified in the early Universe!?



Just as Einstein constructed general relativity with the help of Marcel Grossman a hundred years ago, cooperation with mathematicians may be the key to solve the problem!



KAVLI IPMU Renaissance

- After all, the key to IPMU lies in advancing theoretical physics and unraveling the mysteries of the universe through collaboration between mathematics and physics. (Note that I am a theoretical physicist, too, although the numbers I have been dealing with these days have a unit \ or $...)

- We have started future planning discussion for theoretical physics in cooperation with mathematics, enjoying lively in person discussion after Covid-19 on possible new projects on quantum information.

- New series of Fundamental Seminars to enhance more collaboration between mathematicians and theoretical physicists have started. More attendance than monthly colloquium!

KAVLI IPMU to expand into U.Tokyo

KAVLI IPMU to expand into the World

KAVLI IPMU to expand into Japan

KAVLI IPMU to expand into U.Tokyo

One of the missions of wpi World Premier International Research Center Initiative : University reform

Soon after I assumed director of Kavli IPMU last year, I realized the strong administrative office that allows newcommers to start their research activities immediately after their arrival in Japan is one of the major factors in Kavli IPMU's worldwide reputation.

KAVLI IPMU to expand into U.Tokyo

One of the missions of wpi World Premier International Research Center Initiative : University reform

- Soon after I assumed director of Kavli IPMU last year, I realized the strong administrative office that allows newcommers to start their research activities immediately after their arrival in Japan is one of the major factors in Kavli IPMU's worldwide reputation.
- Why not spread this IPMU system throughout the entire university, or at least the entire Kashiwa campus?
- Directors/Deans of Institutes in Kashiwa campus meet every other months (with a drinking party), and I raise it to them.
- I also visited MEXT to consult with possibility of getting extra funding toward it, which is not straight forward in the current system.
- I believe it will be realized in a different scheme, namely,….

KAVLI IPMU to expand into U.Tokyo

KAVLI IPMU to play a similar role to Tomioka Silk Mill, a world heritage.

Not only producing high quality research but also possessing wonderful administration officers who may train new officers to send to other departments throughout the university.

Established in 1973, at that time the world largest silk mill, not only produed high quality silk to export to the West but also trained female factory workers who later played a leading role in the silk mills throughout Japan.

KAVLI IPMU to expand into the World

Thanks to the efforts of Hitoshi and his colleagues, Kavli IPMU is now highly regarded in the international research community.
The WPI mission has been fully accomplished in this regard.

As a further step in this direction, we are preparing agreements with the following institutions.

- Institute of Cosmology and Gravitation, University of Portsmouth
  JY visited Portsmouth in October and met director, David Bacon
- Canadian Institute for Theoretical Astrophysics, University of Toronto
  Dick Bond visited Kavli IPMU in November. I learned that they have a very similar concept CITA-incorporated to our Satellite.
- Imperial Center for Inference and Cosmology, Imperial College, London
  Andrew Jaffe has been visiting our CMB group from KEK until Dec..
- Astrocent, Nicolaus Copernicus Astronomical Center, Polish Academy
  Leszek Roszkowski visited us in November after COSMO.
- Yau Mathematical Sciences Center, China
  Ooguri san and Nakajima san

KAVLI IPMU to expand into the World

THE KAVLI FOUNDATION

Directors of 20 Kavli Institutes in the world, representing BIG, SMALL, and COMPLEX got together at the Kavli Foundation headquarter in Los Angels in July.

We made a request for additional funding to enhance cooperation between different Kavli institutes, which resulted in initiation of the **Kavli Institute Collaboration Kickstarter** (KICK) grant program.

KAVLI IPMU to expand into the World

THE KAVLI FOUNDATION

Proposals to collaborate with

Kavli Institute for Cosmological Physics, The University of Chicago

Kavli Institute for Cosmology, University of Cambridge

Kavli Institute for Astronomy and Astrophysics, Peking University

are in preparation.

KAVLI IPMU to expand into Japan

Previously, visitors coming to Kavli IPMU all the way from abroad had to return home without stopping anywhere after their stay at Kavli IPMU in order to receive round-trip airfare.

> It would be a pity for those who have traveled a long way to Japan to have to return home after only a few days at IPMU. It would be nicer for them to visit other institutions to learn more about Japan and contribute to science in Japan.

Therefore, we have changed the invitation travel expense rules to allow full payment of travel expenses even when a visitor visits an institution with an IPMU affiliated researcher and then returns directly home. In other words, the institution with the affiliated researcher is regarded as a satellite of Kavli IPMU.

Win Visitor enjoys visits to other places in Japan.

Win Affiliate member enjoys hosting visitors.

Win Both contribute more to IPMU.

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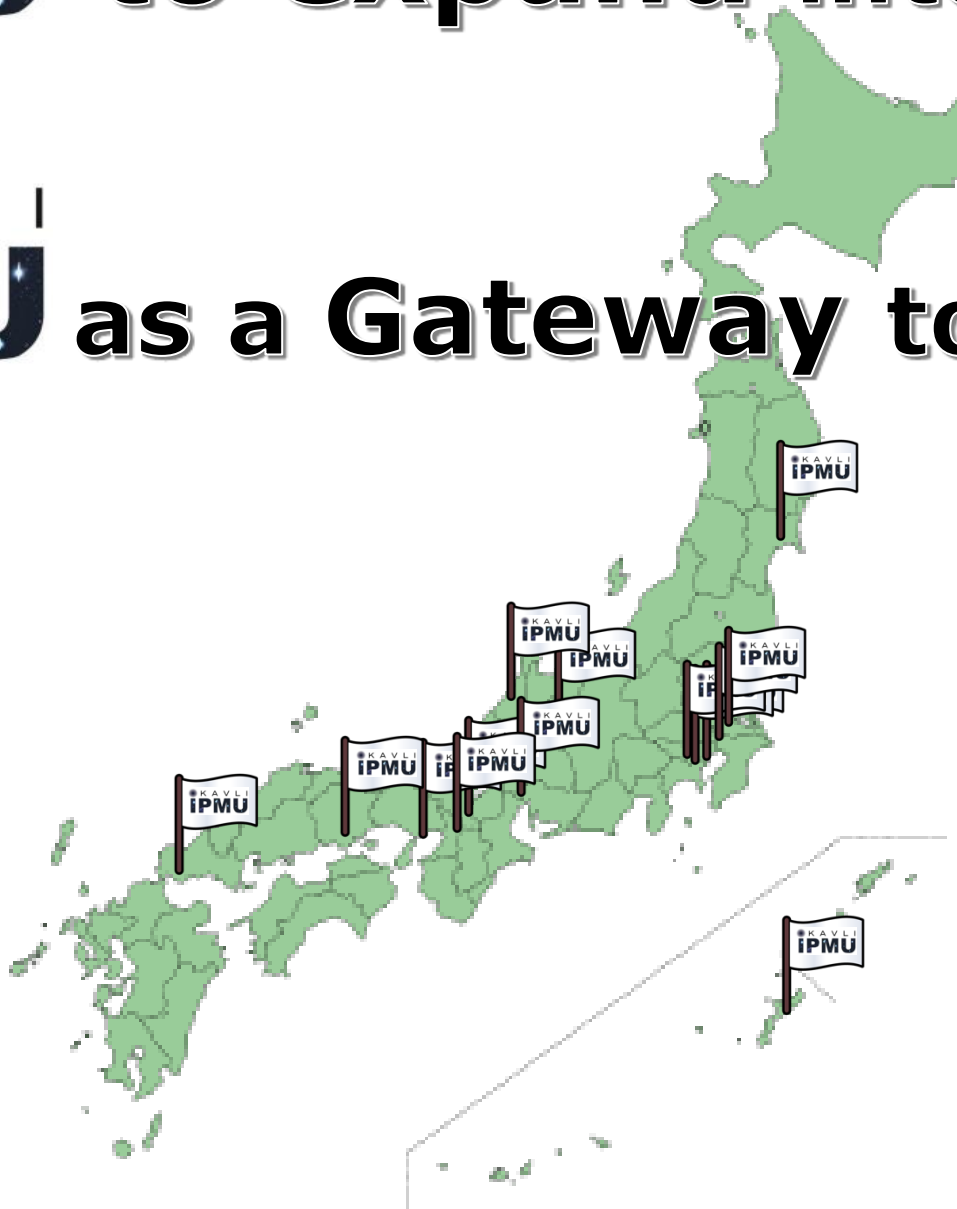
KAVLI IPMU as a Gateway to the World

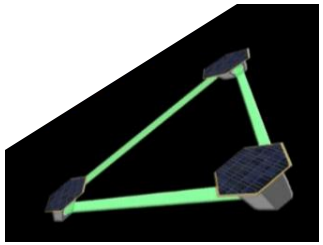


KAVLI IPMU as a Gateway to the World

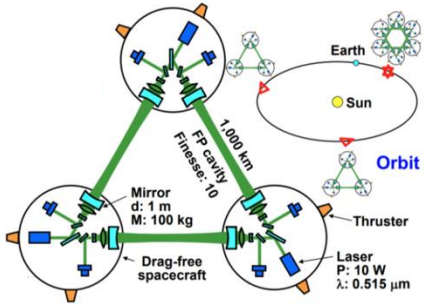
#2

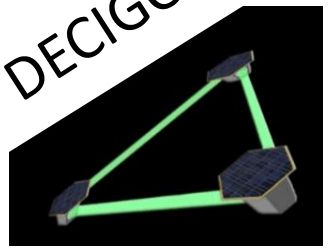
- Making use of this high international reputation of KAVLI IPMU, KAVLI IPMU can function as a networking hub toward the realization of next-generation large-scale research projects for which international cooperation is essential.
- KAVLI IPMU to support the cradle of such a long-term, large-scale project that is of high scientific significance but that cannot be carried out in Japan alone.

KAVLI IPMU: Driving Force of International Cooperation



I have a space-based gravitational wave project DECIGO in mind…



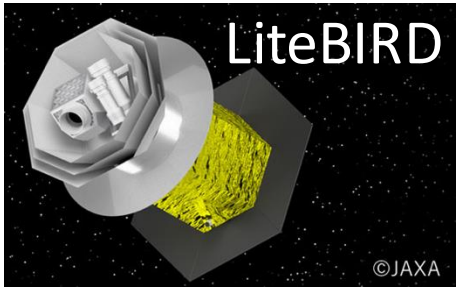


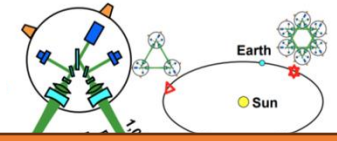
Space based gravitational wave detector
that may determine when Big Bang happened!

Such a far-reaching project
may only be possible after

successful ground based
GW detection in Japan

successful space based
cosmology in Japan





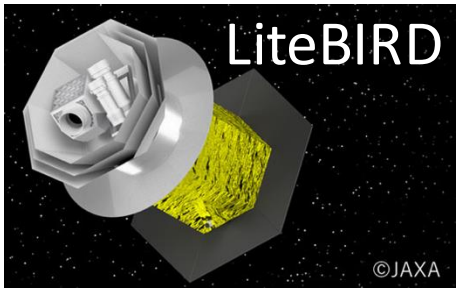
DECIGO

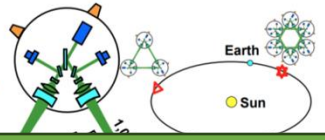
International Gravitational Wave observatory Network (IGWN) will be established soon to replace LIGO-Virgo-KAGRA collaboration with a single entity, which means KAGRA must become more international. Future planning of our Kamioka Satellite in this new situation will be our next task.

be possible after

successful gro sed GW detecti Japan

successful space based cosmology in Japan





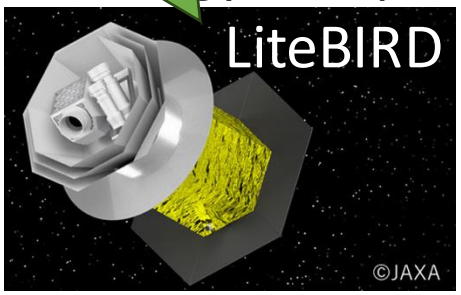
DECIGO

Tomo Matsumura has been appointed as the PI of the LiteBIRD collaboration. He will lead the creation of a feasible plan for LiteBIRD over the next year. We will support him as much as we can!

may only be possibl

successful ground based GW detection in Japan

suc space based cosm gy in Japan



Since it takes longer than expected anyway for a large project to be realized, it is necessary to review it from time to time.

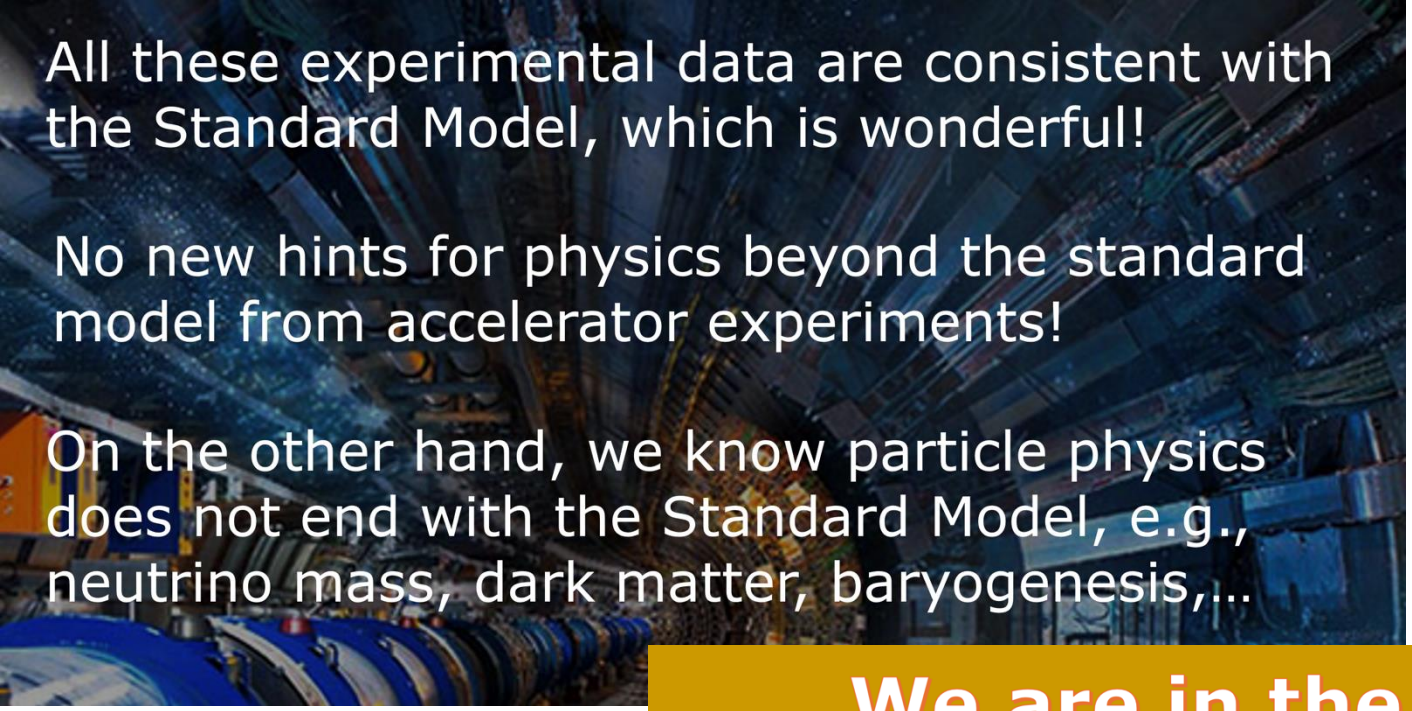
Although I mentioned several indicative numbers, the most important are scientifically significant achievements. Masahiro and I had a chat about research that could win a Nobel Prize.

- Primordial Black Hole Dark Matter verified by Subaru HSC
- Dark Energy evolving nontrivially in time by Subaru PFS
- CMB B-mode polarization detection by LiteBIRD
- Axions through cosmological birefringence

- Inflationary cosmology
- Neutrino mass through seesaw mechanism

- Your next-to-the-next-to-the next paper

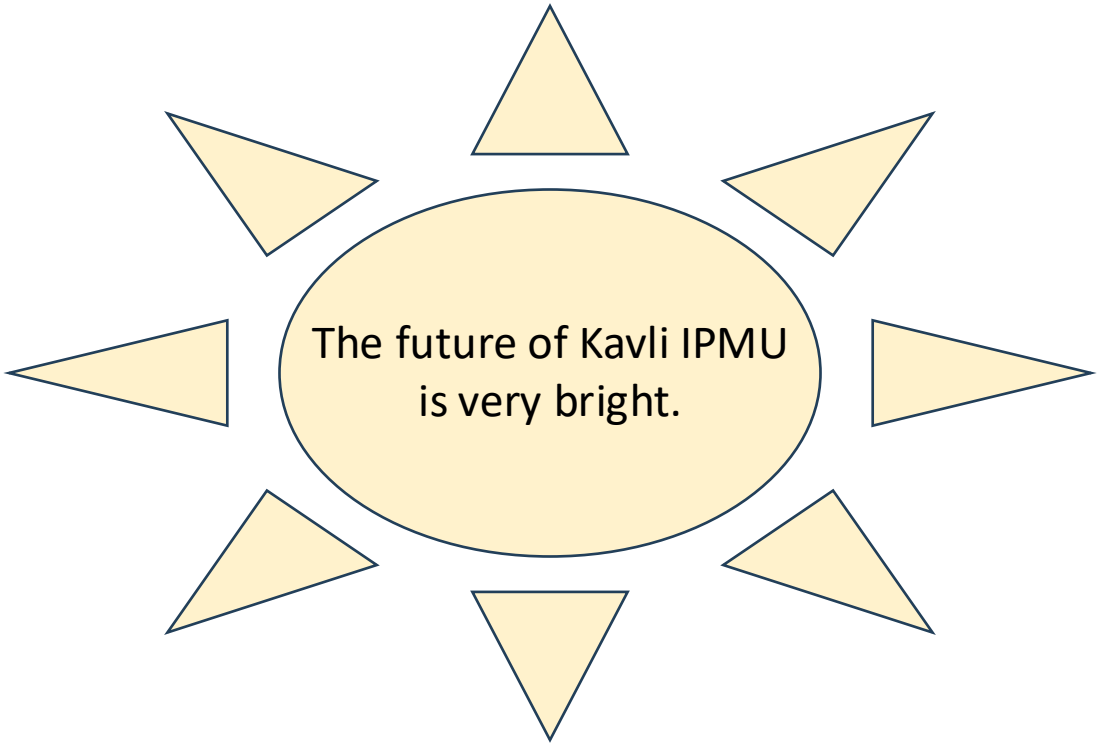
ββ experiment?



We are in the Golden Age of Theoretical Particle Physics, free from any experimental hints that would restrict free thinking.

KAVLI IPMU is the best place to foster such free ideas!!

NB Note that when I started my research on cosmology of the early universe in 1980s, there were practically no observational clues, and we were free to say anything!


The future of Kavli IPMU
is very bright.

HitoshiFest

Realizing even more prosperous Kavli IPMU will be our biggest 60th birthday present to you, Hitoshi!