

# KEK-PH Lectures and Workshops 2021

 1 May 2021, 12:00 → 31 Mar 2022, 14:00 Asia/Tokyo

**Description** **"KEK-PH lectures and workshops" is a form of KEK-PH workshop series at the time of Covid-19.**

The annual KEK Theory Meeting on Particle Physics Phenomenology (KEK-PH) covers many topics in Particle Physics and Cosmology, from the Standard Model and models beyond it to particle cosmology and astrophysics. At the time of Covid-19, the KEK theory center is organizing an on-line lecture and workshop series, "KEK-PH lectures and workshops 2021."

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## 6th KEK-PH + 2nd KEK-COSMO joint mini-workshop

This time the KEK Theory Center is organizing the phenomenology and cosmology-themed mini workshop, the 6th KEK-PH and the 2nd KEK-Cosmo, which is mainly made up of contribution talks by young researchers held on 9th and 10th, March, 2022. Prior to the session of the contributed talks, on the morning of the 9th, we are going to hold a special invited talk by Prof. Wei Xue (U of Florida) about the structure formation by axion.

**Program:**

<https://conference-indico.kek.jp/event/141/timetable/#day-2022-03-09>

**Plenary session**

Mar. 9th (Wed.) 11:05-12:00:

Prof. Wei Xue (University of Florida), "Resonant excitation of the axion field during the QCD phase transition"

**Short talk sessions**

Mar. 9th (Wed.) 13:30-16:55 and Mar. 10th (Thu.) 11:00-16:55

We invite the following young researchers to give talks:

Yoshihiko Abe (Kyoto U.), "Origin of pseudo-Nambu-Goldstone dark matter"

Kazuki Enomoto (Osaka U), "Electroweak baryogenesis in the three-loop neutrino mass model with dark matter"

Motoko Fujiwara (Nagoya U), "Electroweakly interacting spin-1 dark matter and its phenomenology"

Yu Hamada (KEK), "Electroweak-Skyrmion as Asymmetric Dark Matter"

Minxi He (KEK), "Reheating after Mixed Higgs- $R^2$  Inflation"

Asuka Ito (TITech), "Searching for axion dark matter/gravitational waves with magnons"

Naoya Kitajima (Tohoku U.), "Parametric resonance instability of the QCD axion"

\* In the short talk sessions, all topics (including those not related with the plenary talk) are welcome. Also, contributions from students, postdocs and faculty staffs are all welcome.

**Registration dead line:**

23rd (Wed.) Feb. 18:00 (JST), to apply for a short talk

8th (Tue.) Mar. 18:00 (JST), only for your participation

Zoom link will be sent to the registered e-mail address.

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## The 5th KEK-PH on "Jet Physics"

In the search for new physics at the LHC experiment, jet is often produced from heavy particle decays. By studying the jet structure, we can reconstruct particles with high momentum, such as W, Z, top, and H, and increase the sensitivity to new physics. In "KEK-PH Jet Physics", we will discuss recent theoretical developments, the latest data from the ATLAS and CMS experiments, and the expected sensitivity at the HL-LHC from both theoretical and experimental perspectives.

**Program:**

<https://conference-indico.kek.jp/event/141/timetable/#b-1199-kek-ph-jet-physics>

**Invited talks****Nov. 30th (Tue.)**

16:15-17:00: Prof. Takuya Nobe (ICEPP, Tokyo), "Jet physics with ATLAS"

17:00-18:00: Prof. Gavin Salam (Oxford), "Jets through the LHC era"

**Dec. 1st (Wed.)**

10:00-10:45: Prof. Cristina Mantilla (FermiLab), "Boosted jet physics in CMS"

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## The 4th KEK-PH on "New Ideas in Particle Physics"

We are now preparing a workshop on "New ideas in particle physics," on Nov. 16 and 17. This time, it is a joint workshop with Florida State University (co-organizer: Kosaku Tobioka). The topics cover cosmological solutions to the naturalness problems, swampland conjectures, as well as quantum gravity effects on low energy physics.

**Program**<https://conference-indico.kek.jp/event/141/timetable/#day-2021-11-16>**Invited talks****First day:****16th (Tue.), Nov. 16:00-19:15 (JST)**

- Michael Geller (Tel Aviv U.), "Crunching Naturalness"
- Raffaele D'Agnolo (IPhT, Saclay), "Aspects of Cosmological Selection of the Weak Scale"
- Gia Dvali (Munich U., ASC and Munich, Max Planck Inst.), "S-matrix exclusion of de Sitter landscape, and naturalness"
- Matthew McCullough (CERN), "Gegenbauer Goldstones"

**Second day:****17th (Wed.), Nov. 9:00-12:30 (JST)**

- Surjeet Rajendran (Johns Hopkins U.), "A Causal Framework for Non Linear Quantum Mechanics"
- Anson Hook (Maryland U.), "Solving the naturalness puzzle using old ideas"
- Yuta Hamada (Harvard U.), "Brane Probes, Finiteness and Distance Conjecture"
- Tom Rudelius (UC, Berkeley), "Consequences of No Global Symmetries in Quantum Gravity"

**Registration dead line:**

15th (Mon.) Nov. 18:00 (JST)

Zoom link will be sent to the registered e-mail address.

**Sponsor:**

Grant-in-Aid for Scientific Research on Innovative Areas (18H05542), Japan

Scientific Research A (19H00689), Japan

Scientific Research B (21H01086), Japan

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## The 3rd KEK-PH + 1st KEK-Cosmo joint workshop on "Primordial Black Holes"

Convener(s): Kazunori Kohri and Kyohei Mukaida (KEK/Theory)

**Program**<https://conference-indico.kek.jp/event/141/timetable/#day-2021-10-19>**Invited talks****First invited talk:**

19th (Tue.), Oct. 16:00-17:30 (JST):

Dr. Gabriele Franciolini (Geneva U), "Primordial Black Holes and Gravitational Wave Observations"

**Second invited talk:**

20th (Wed.), Oct. 16:00-17:30 (JST):

Dr. Christian Byrnes (Sussex U), "Primordial black holes as a LIGO-Virgo and dark matter candidate"

**13:00** → 16:00 **The KEK-PH + KEK-Cosmo joint workshop on "Primordial Black Holes": Short talks****Convener:** Dr Kazunori Kohri (KEK)**13:30** **Primordial Black Holes from Long-Range Scalar Forces and Scalar Radiative Cooling**  30m

Primordial black holes (PBHs) are a natural consequence of long-range scalar forces in the early Universe. These forces can lead to the formation of halos of heavy particles, Q-balls or oscillons even during the radiation dominated era. This same force removes energy and angular momentum from virialized systems via scalar radiation, leading to the subsequent formation of black holes. We will discuss two scenarios which result in the formation of PBHs. First, we consider heavy fermions interacting via a light scalar mediator. This scenario relates the mass of the dark-sector particles to the masses and abundance of dark matter PBHs in a way that can explain why dark matter and ordinary matter have similar mass densities. Second, we consider interactions among SUSY Q-balls. The mass and abundance of PBHs in this scenario are naturally explained by the SUSY breaking scale. Lastly, we will comment on the expected PBH spins from this formation mechanism in comparison to other earlier models.

**Speaker:** Mr Marcos Flores (UCLA)**14:00** **Primordial black holes in peak theory with a non-Gaussian tail**  30m

In this work, we update the peak theory for the estimation of the primordial black hole (PBH) abundance, particularly by implementing the critical behavior in the estimation of the PBH mass and employing the averaged compaction function for the PBH formation criterion to relax the profile dependence.

We apply our peak theory to a specific non-Gaussian feature called the exponential tail, which is characteristic in ultra slow-roll models of inflation. With this type of non-Gaussianity, the probability of a large perturbation is not suppressed by the Gaussian factor but decays only exponentially, so the PBH abundance is expected to be much enhanced.

Not only do we confirm this enhancement even compared to the case of the corresponding nonlinearity parameter  $f_{NL} = 5/2$ , but also we find that the resultant PBH mass spectrum has a characteristic maximal mass which is not seen in the simple Press-Schechter approach.

**Speaker:** Dr Yuichiro Tada (Nagoya U)**14:30** **Spins of primordial black holes formed in the radiation-dominated phase of the universe: first-order effect**  30m

The standard deviation of the initial values of the nondimensional Kerr parameter  $a^*$  of primordial black holes (PBHs) formed in the radiation-dominated phase of the universe is estimated to the first order of perturbation for the narrow power spectrum. Evaluating the angular momentum at turn around based on linearly extrapolated transfer functions and peak theory, we obtain the expression. This implies that for  $M=MH$ , where  $MH$  is the horizon mass at the horizon entry, the higher the probability of the PBH formation, the larger the standard deviation of the spins, while PBHs of  $M \ll MH$  formed through near-critical collapse may have larger spins than those of  $M=MH$ . In comparison to the previous estimate, the new estimate has the explicit dependence on the ratio  $M/MH$  and no direct dependence on the current dark matter density. On the other hand, it suggests that the first-order effect can be numerically comparable to the second-order one.

**Speaker:** Prof. Tomohiro Harada (Rikkyo U)**15:00** **Ultrahigh-energy Gamma Rays and Gravitational Waves from Primordial Exotic Stellar Bubbles**  30m

We put forward a novel class of exotic celestial objects that can be produced through phase transitions occurred in the primordial Universe. These objects appear as bubbles of stellar sizes and can be dominated by primordial black holes (PBHs). We report that, due to the processes of Hawking radiation and binary evolution of PBHs inside these stellar bubbles, both electromagnetic and gravitational radiations can be emitted that are featured on the gamma-ray spectra and stochastic gravitational waves (GWs). Our results reveal that, depending on the mass distribution, the exotic stellar bubbles consisting of PBHs provide not only a decent fit for the ultrahigh-energy gamma-ray spectrum reported by the recent LHAASO experiment, but also predict GW signals that are expected to be tested by the forthcoming GW surveys.

**Speaker:** Mr Qianhang Ding (HKUST)**15:30** **Break**  30m**16:00** → 18:00 **The KEK-PH + KEK-Cosmo joint workshop on "Primordial Black Holes": 1st Invited Talk****Convener:** Dr Mukaida Kyohei (KEK)**16:00** **Primordial Black Holes and Gravitational Wave Observations**  2h

Primordial Black Holes might comprise a significant fraction of dark matter in the Universe and can give rise to observable signatures at current and future gravitational wave experiments. First, we review the PBH model and discuss how accretion and clustering may affect the properties of PBH binaries. Second, we confront the PBH model with LIGO/Virgo data showing its upsides and shortcomings, by also including state-of-the-art astrophysical models in a multi-population inference. Finally, we discuss how 3G detectors, such as Einstein Telescope and Cosmic Explorer, may be able to discover a PBH population by searching for high redshift merger events.

**Speaker:** Dr Gabriele Franciolini (Geneva U)

WEDNESDAY, 20 OCTOBER


**16:00** → 18:00 **The KEK-PH + KEK-Cosmo joint workshop on "Primordial Black Holes": 2nd Invited Talk****Convener:** Kazunori KOHRI (KEK/Theory)**16:00** **Primordial black holes as a LIGO-Virgo and dark matter candidate** 2h

Although black holes can be the remnants of dead stars, it is also possible that some are primordial. Such primordial black holes are the unique dark matter candidate which is not a new type of particle, and they could also explain some of the unexpected properties of the black hole mergers that LIGO and Virgo have detected. I will summarise the evidence and (fine-tuning) challenges behind this claim, including a new Bayesian model comparison between astrophysical and primordial black holes.

I will also discuss the interesting coincidence of scales between the LIGO events, Chandrasekhar limit and the horizon mass during the QCD transition in the early universe, and the wavelength of gravitational waves on which NANOGrav may (potentially) have detected a stochastic gravitational wave background.

**Speaker:** Dr Christian Byrnes (Sussex U)


## TUESDAY, 16 NOVEMBER

**16:00** → 19:15 **KEK-PH New Ideas in Particle Physics: 1st day****16:00** **Crunching Naturalness** 45m**Speaker:** Michael Geller (Tel Aviv U.)**16:45** **Aspects of Cosmological Selection of the Weak Scale** 45m**Speaker:** Raffaele D'Agnolo (IPhT, Saclay) RaffaeleD'Agnolo.pdf**17:30** **Break** 15m**17:45** **S-matrix exclusion of de Sitter landscape, and naturalness** 45m**Speaker:** Gia Dvali (Munich U., ASC and Munich, Max Planck Inst.)**18:30** **Gegenbauer Goldstones** 45m**Speaker:** Matthew McCullough (CERN) MatthewMcCulloug...

## WEDNESDAY, 17 NOVEMBER

**15:20** → 16:55 **KEK-PH + KEK-COSMO joint mini-workshop: Second afternoon session****Convener:** Ryutaro Matsudo


15:20

**Electroweakly interacting spin-1 dark matter and its phenomenology**  35m**Speaker:** Motoko Fujiwara (Nagoya University) KEK-PH-Motoko\_Fuj...

15:55

**Chiral Composite Asymmetric Dark Matter**  25m**Speaker:** Keiichi Watanabe (The University of Tokyo, ICRR) KEK-PH\_2.pdf

16:20

**Electroweak-Skyrmion as Asymmetric Dark Matter**  35m**Speaker:** Yu Hamada (KEK) kek-ph-cosmo\_ham...