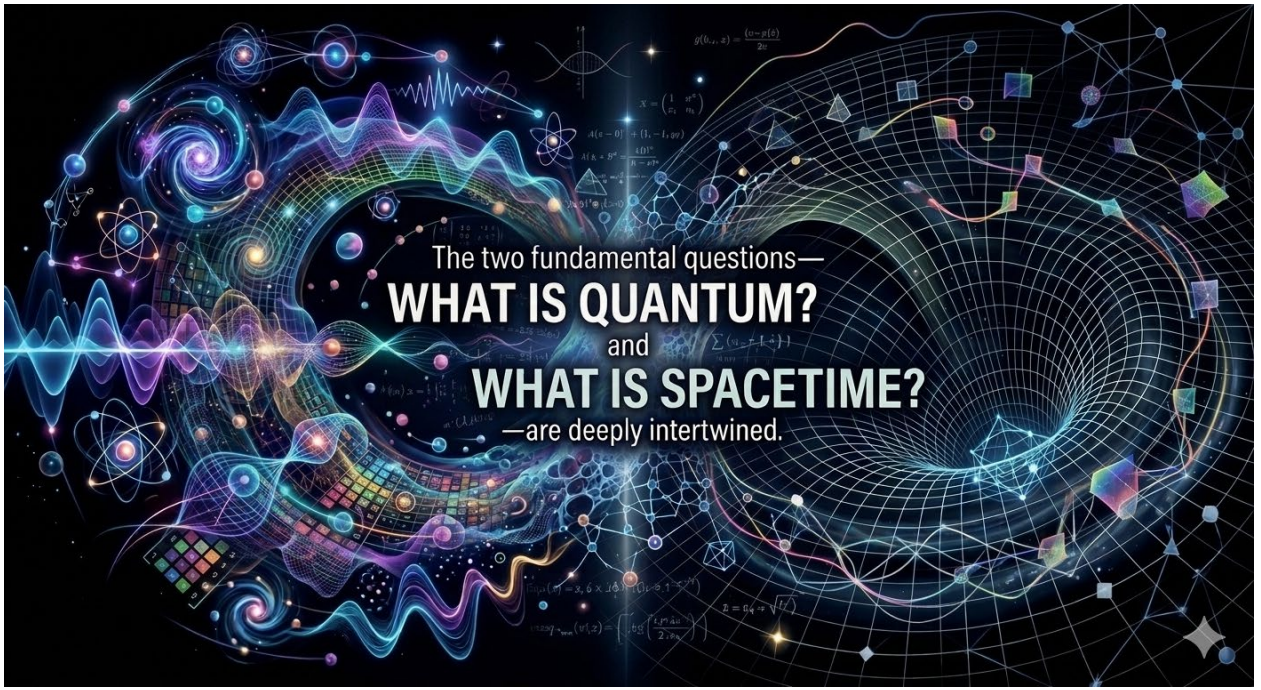
Yuki Yokokura (KEK/iTHEMS)
(on behalf of organizers)

Workshop jointly organized
by KEK Theory Center and RIKEN iTHEMS

iTHEMS

Motivation for this workshop was…

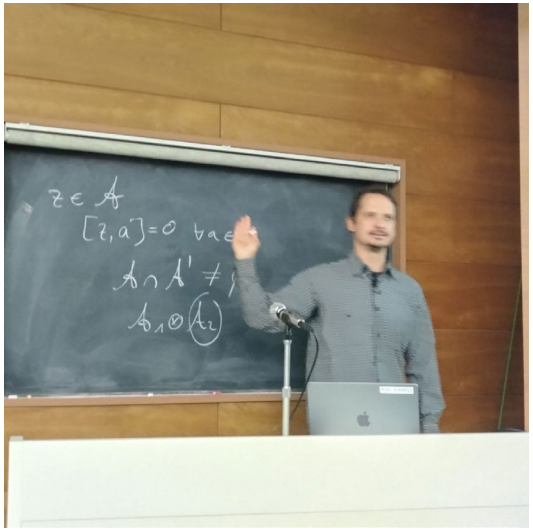


- Formulation of quantum theory depend on our conceptions of time and space.
- Revision of our understanding of spacetime from quantum nature
- How to quantize classical spacetime
- How (semi-) classical descriptions of spacetime emerge from quantum theory.
- Role of thermodynamics/statistical mechanics.

⇒“How can quantum theory and spacetime be understood in a consistent manner?”

⇒ What happened in this workshop? Let’s review together.

Day 1

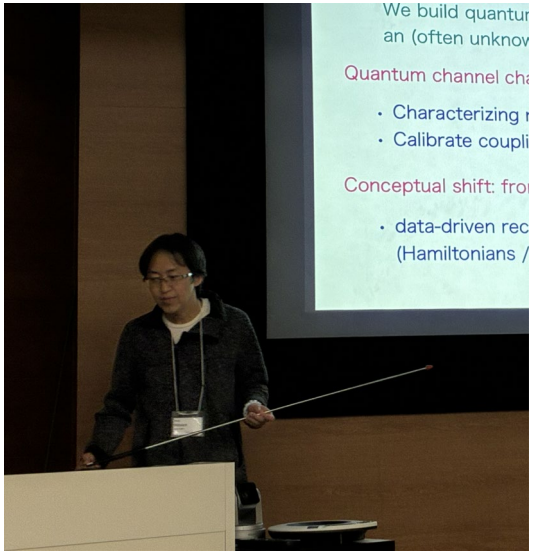


Philipp Höhn

"Relational entanglement entropies in gauge theory and gravity"

Ginestra Bianconi

"Gravity from Entropy"

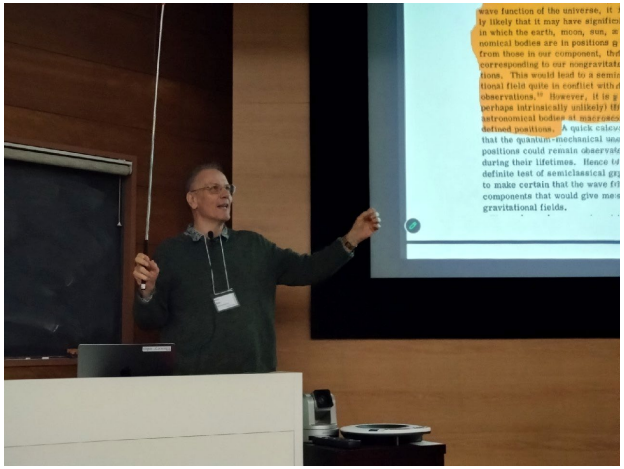


Shunji Matsuura

"Quantum State Transfer from Natural Systems via Hamiltonian Learning and Information Scrambling"

Poster Session

Day2



Adrian Kent

"Problems and possibilities for semi-classical gravity theories"

Akira Matsumura

"Gravity sourced by quantum matter: a subjective overview"

Hidetoshi Katori

“Optical lattice clocks to see curved spacetime”

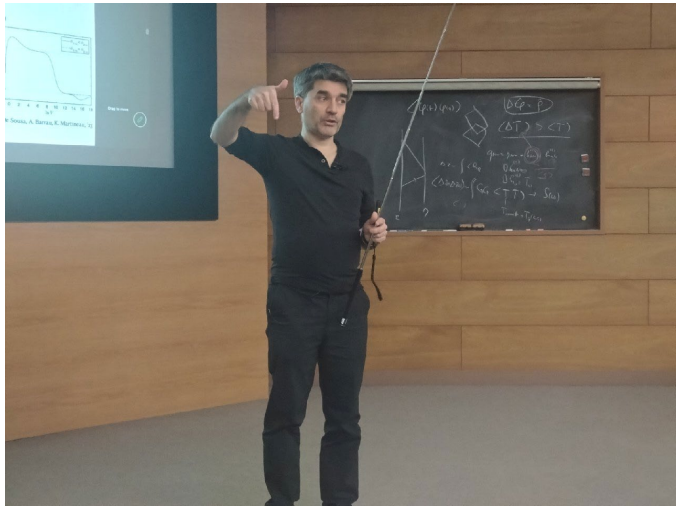
Marios Christodoulou

“Observables in Table Top Quantum Gravity”

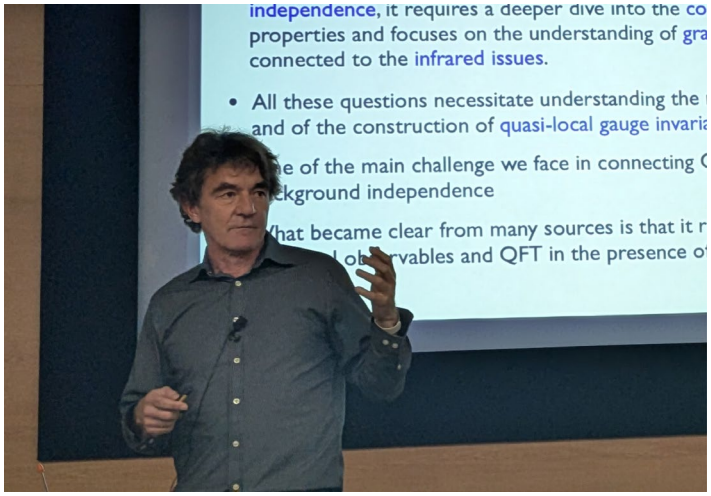
Bob Coecke

"From quantum picturalism, to education, AI, spatial cognition, and music"

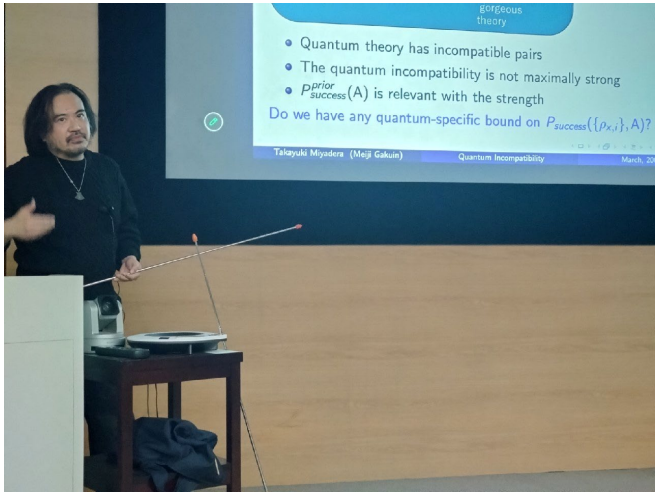
Day 3



Daniele Oriti
"Emergent spacetime and cosmology from quantum gravity"



Laurent Freidel
"Quantum Null Ray: localized gauge invariant observables and covariant quantization"



Takayuki Miyadera
"Quantum Incompatibility"

Fay Dowker
"What is the Gravitational Path Integral?"

Day 4

Djordje Minic

“Quantum gravity, quantum spacetime and gravitized quantum theory"

Tamiaki Yoneya

"The Meaning of Spacetime in String/M Theory"

Panel Discussion Session!

The elements we got

Scrambling

Entropy

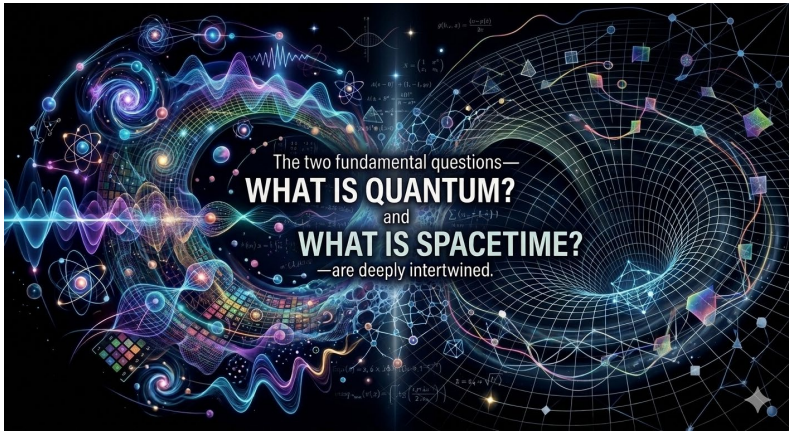
Quantum Reference Frame

superposition/decoherence
of gravity/spacetime

Quantum picturalism

Semi-classical gravity

Quantum Incompatibility



Observables in
Quantum Gravity

Double path integral

Emergence of spacetime
from superspace

precise measurement
of time (and space)

Gravitization

Quantum Null Ray

Quantum String Geometry

I hope that the discussions at this meeting inspired you, and that some non-trivial and interesting ideas will emerge from among you someday.

13 short talks

- **Clelia Altomonte** *"A Quantum Algorithm for Numerical General Relativity"*
- **Srijit Bhattacharjee** *"Dynamical black holes and their entropy"*
- **Chong-Sun Chu** *"Large N quantum mehanical model of black hole"*
- **Satoya Imai** *"Chiral Symmetries and Multiparticle Entanglement"*
- **Youka Kaku** *"A Cosmic Cat State and Decoherence in the Early Universe“*
- **Marius Ernst Hagen Krumm** *"Variational quantum sensing using Unruh-DeWitt detectors"*
- **Isaac Layton** *"Fixing semi-classical dynamics from first principles: how to derive effective classical-quantum dynamics from open quantum theory"*
- **Luca Marchetti** *"Cosmic Acceleration from Quantum Gravity: Emergent Inflation and Dynamical Dark Energy"*
- **Jun Nishimura** *"Emergence of (3+1)-dimensional expanding spacetime from the Lorentzian type IIB matrix model"*
- **Emanuele Panella** *"Entanglement mediation in classical–quantum gravity: A lattice approach"*
- **Francesco Sartini** *"Soft edges: the relationships between soft and edge modes"*
- **Muhammad Taufiqi** *"Advances in Quantum Teleportation: Encryption, Steering and Nonlocal Certification, and Superiority in Noisy Quantum Networks"*
- **Julian De Vuyst** *Linearisation instabilities and crossed products"*

22 poster talks

- **Shun Arai** "Wigner Function Shapelets“
- **Tomohiro Fujita,** "Quantum Field Theory of a Scalar Field in Superposed Gravitational Potentials“
- **Hideo Furugori** "Apparent horizon associated with black hole entropy“
- **Tomoya Hirotani** "Quantum fluctuations of geodesic deviation in Oppenheim’s relativistic semi- classical gravity model"
- **Adil Imam** "Rotating Kaluza-Klein Black Holes in Einstein-Maxwell-Dilaton Gauss-Bonnet Gravity and Flat Directions"
- **Marius Ernst Hagen Krumm** "Variational quantum sensing using Unruh-DeWitt detectors"
- **Masatoshi Kubota** "Quantum Geometry in Non-compact Quantum Systems and Frame-Induced Quantum Phase Transitions"
- **Koichi Kyo** "Scattering Amplitudes in the Double Sigma Model"
- **Elena Maria Giulia Landrò** "Intertwiners in Three-Dimensional Chern–Simons Theory"
- **Isaac Layton** "Preserving the thermal state in mixed classical-quantum systems"
- **Mayank** "Probing curved spacetime using bitensors"
- **Andres Gonzalez Morales** "Holography in General Discrete Spacetimes: Cochain Quantum Fields on Simplicial Screens"
- **Naoya Ogawa** "Time as a Measurement-Induced Operator: The Lee–Tsutsui Formalism with a Gaussian Wave-Packet Basis“
- **Goncalo Araujo Regado** "How to make the universe tick"
- **Harkirat Singh Sahota** "Aspects of quantum cosmology with a reference fluid: Ambiguities and their imprints“
- **Leonardo Sanhueza “**Null foliations on conformally compactified spacetimes"
- **Taishi Sano** "Schrödinger Symmetry in Static Spherically-symmetric Mini-superspaces with Matter Fields"
- **Fumiya Sano** "Decoherence of primordial perturbations in the view of a local observer"
- **Keito Shimizu** "Boundary electromagnetic duality (tentative)"
- **Yuka Shiomatsu** "Boosting Gravity-Induced Entanglement through Parametric Resonance“
- **Muhammad Taufiqi** "On the Quantum Teleportation Superiority in Noisy Environments“
- **Takuya Yoda** "String wave packets and termination of Hawking radiation"

Always discussion!

Lunch time

Reception

Everyone contributed!
Thank you!

- ✓ **Ask various questions during talks.**
- ✓ **Discuss many things during coffee breaks and lunch time.**
  - **Make your friends?**
  - **Enjoy our workshop?**

Best Poster Awards

- **We had 21 poster presentations.**
- **The invited speakers reviewed them. (Thank you very much!)**
- **Based on their voting, we selected Top 3 as Best Poster Awards:**

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#1. Shun Arai (Kobayashi-Maskawa Institute, Nagoya)

"Wigner Function Shapelets“

#3.Hideo Furugori (Kyoto Univeristy)

"Apparent horizon associated with black hole entropy“

#20.Yuka Shiomatsu (Ochanomizu University)

"Boosting Gravity-Induced Entanglement through Parametric Resonance"

Congratulations!

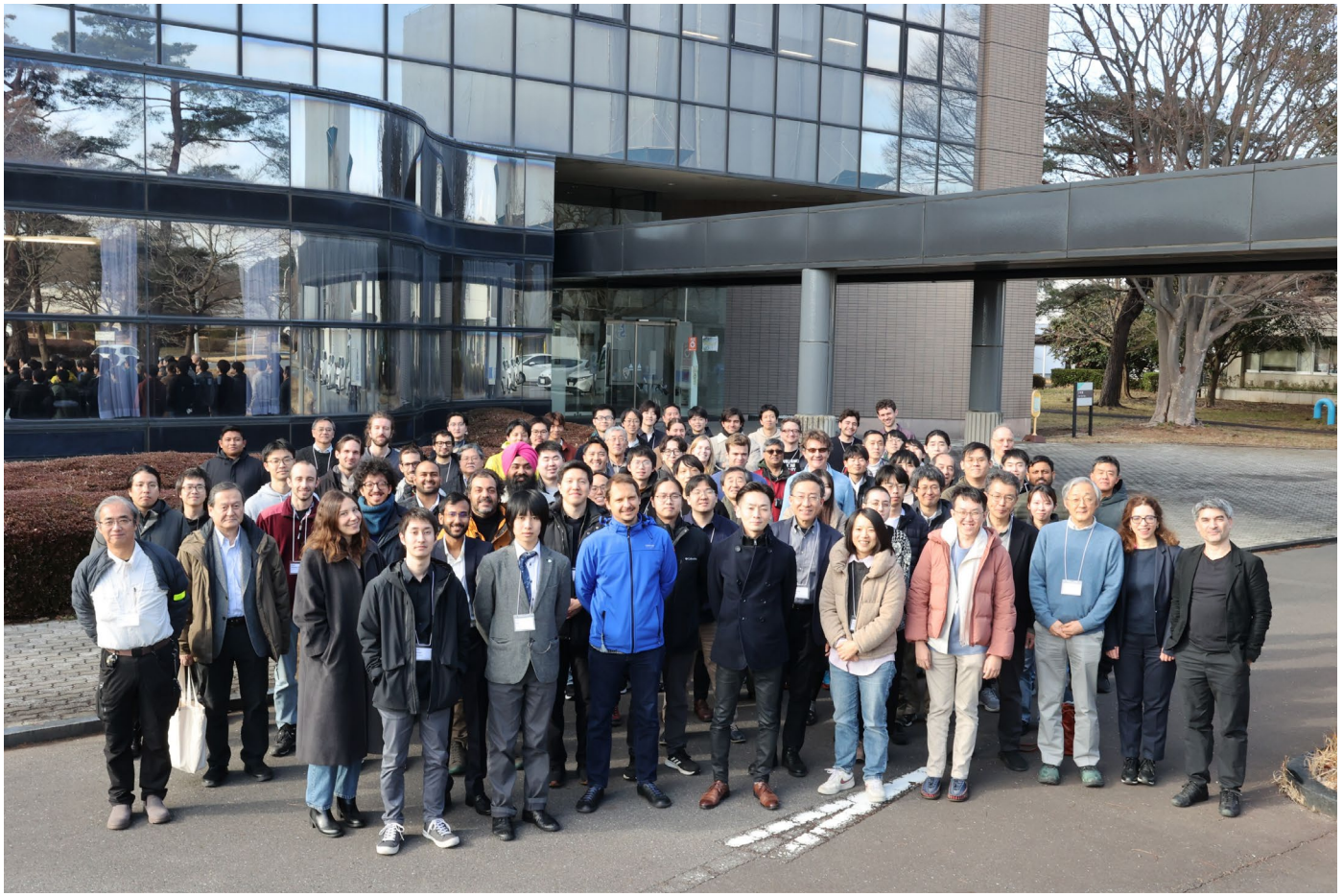
Thank you, our team!

- **Organizers**

- Yuta Hamada (KEK)
- Puttarak Jai-akson (RIKEN)
- Christy Kelly (RIKEN)
- Amaury Micheli (RIKEN)
- Kyohei Mukaida (KEK)
- Wei-Hsiang Shao (RIKEN)
- Yutaka Shikano (University of Tsukuba)
- Yuko Urakawa (KEK)
- Yuki Yokokura (Chair, KEK/RIKEN)

- Secretaries (KEK):
  Tomoko Numata, Yuko Ohno, Maki Ohishi (main)

Some students also support this event.



Thank you very much!

Have a safe trip to your home! See you again! (next time?)