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Membership of academic societies:
The Physical Society of Japan (JPS)

Research Interest:

- Gravitational theory
- Cosmology

Research Summary:

I am working on gravitational theory. My final purpose is the construction of the quantum theory of gravity.

General relativity, proposed by A. Einstein, is the fundamental theory of classical gravity. This theory has mathematically interesting aspects, and thus many researchers are investigating its mathematical structure. Moreover, general relativity is an excellent theory in physics since no conflicts with experimental results and observational facts have been found.

Although general relativity is an excellent theory of classical gravity, there is a problem; "its straightforward quantization does not work well." Since the fundamental physics except gravity is described as quantum theory, the quantization of gravity theory is required to unify all theories of fundamental physics. Because the quantization of general relativity doesn't go well, by modifying or extending general relativity (or also modifying the quantum theory) many researchers try to construct the unified theory describing all physical phenomenon. The strong candidate is the super string theory.

Toward the construction of quantum gravity theory, we have the following three topics to work on;

- Investigating the mathematical structures of fundamental classical theory of gravity, general relativity
- Approaching the quantum gravity theory by the investigation of the possible extension from general relativity.
- Investigating the mathematical structures of candidates of quantum gravity theory, such as the string theory.

I am mainly working on the second topic, e.g. the property of the general relativity in higher dimension and the causal structures in extended theory from the general relativity.

Major Publications:

[1] K. Izumi, K. Koyama, O. Pujolas and T. Tanaka, "Bubbles in the Self-Accelerating Universe," Phys. Rev. D **76**, 104041 (2007)

[2] K. Izumi, "Orthogonal black di-ring solution," Prog. Theor. Phys. **119**, 757 (2008)

[3] K. Izumi and S. Mukohyama, "Nonlinear superhorizon perturbations in Horava-Lifshitz gravity," Phys. Rev. D **84**, 064025 (2011)

[4] K. Izumi, "Causal Structures in Gauss-Bonnet gravity," Phys. Rev. D **90**, no. 4, 044037 (2014)
[5] T. Fujimori, T. Inami, K. Izumi and T. Kitamura, "Tree-Level Unitarity and Renormalizability in Lifshitz Scalar Theory," PTEP **2016**, no. 1, 013B08 (2016)
[6] R. Emparan, K. Izumi, R. Luna, R. Suzuki and K. Tanabe, "Hydro-elastic Complementarity in Black Branes at large D," JHEP **1606**, 117 (2016)

Education and Appointments:

2009 D. Sc., Department of Physics, Kyoto University, Japan
2009 Postdoctoral Fellow, Institute for the Physics and Mathematics of the Universe, The University of Tokyo
2011 Postdoctoral Fellow, Yukawa Institute for Theoretical Physics, Kyoto University
2011 Distinguished Young Postdoctoral Fellow, Leung Center for Cosmology and Particle Astrophysics, National Taiwan University, Taiwan(R.O.C)
2015 Postdoctoral Fellow, Department of Physics, University of Barcelona, Spain,
2016 Assistant Professor, Department of Mathematics, Nagoya University

Message to Prospective Students:

General relativity is constructed with a simple equation, but has the various nontrivial properties. Meanwhile, the construction of quantum gravity theory is a challenging research topic. If you want to study one of them (or both), don't hesitate to ask me.

If you want to study these topics, it is better to start from the basics of general relativity. I recommend the following book;

- R. M. Wald, General Relativity, Chicago University Press

After mastering the basics of general relativity, you can go to the next step, reading the other books and papers that you are interested in.