The 2025 (71st) Nishina Memorial Prize

The Nishina Memorial Prize, established in 1955, is awarded annually by the Nishina Memorial Foundation to researchers who have made outstanding achievements in the field of atomic and subatomic physics. The 2025 (71st) Prize recognizes three scientists: Dr. Mareki Honma (National Astronomical Observatory of Japan) for his pioneering role in imaging the shadows of supermassive black holes, and Drs. Hal Tasaki (Gakushuin University) and Masaki Oshikawa (The University of Tokyo) for their theoretical and mathematical studies on quantum spin systems. Their achievements have significantly deepened our understanding of fundamental physical laws, from the strong gravity near black holes to the topological nature of quantum matter.

1) Dr. Mareki Honma

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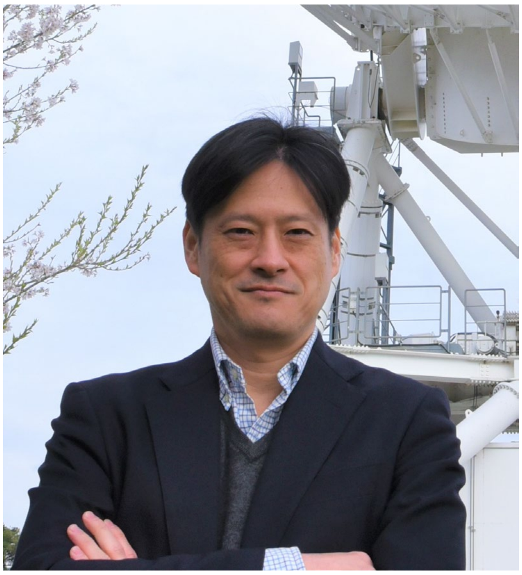

"Contributions to imaging the shadow of supermassive black holes with very long baseline interferometry"

Observing and testing black holes at the scale of the event horizon, as predicted by general relativity, has long been one of the greatest challenges in fundamental Physics and astrophysical research. In 2019, the Event Horizon Telescope (EHT) Collaboration succeeded in obtaining an unprecedentedly high-resolution image of the giant black hole at the center of the elliptical galaxy M87, revealing the black hole shadow and surrounding ring structure caused by the presence of the event horizon [1].

Dr. Honma was among the earliest researchers in Japan to organize a group dedicated to the observation of black hole shadows, and he played a leading role in initiating joint VLBI experiments in collaboration with Professor Shepherd Doeleman of Harvard University and other international researchers. As the representative of the Japanese team within the EHT Collaboration, Dr. Honma has consistently provided leadership in both the technological development and scientific analysis of the project.

In particular, he led the development of the optical signal transmission system that enabled the integration of the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile into the EHT network as a phased array, significantly enhancing the array's sensitivity. He also pioneered a new data analysis technique based on sparse modeling, in collaboration with data science specialists, to reconstruct images from interferometric visibility data [2]. This novel approach, developed ahead of the rest of the world, was implemented in the Japanese SMILI software and the U.S.-developed eht-imaging package, and became an essential tool for EHT image reconstruction.

Under Dr. Honma's leadership, the Japanese team took charge of one of three independent imaging pipelines used by the EHT Collaboration to process the M87 data. The sparse modeling analysis, conducted without bias or cross-reference to the other teams, independently confirmed the presence of a black hole shadow. The consistency among the results provided the first compelling visual evidence for the existence of supermassive black holes [3]. Dr. Honma's contribution to the data analysis was crucial in producing the first-ever image of a black hole shadow.

The results were later confirmed through follow-up observations with an increased number of stations [4], and similar images were obtained for the supermassive black hole at the center of our Milky Way galaxy (Sagittarius A*) [5]. Dr. Honma's pioneering contributions to both instrumental and analytical aspects of VLBI have played a decisive role in the success of this international collaboration and have opened new frontiers in the observational study of general relativity.

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2-1) Dr. Hal Tasaki

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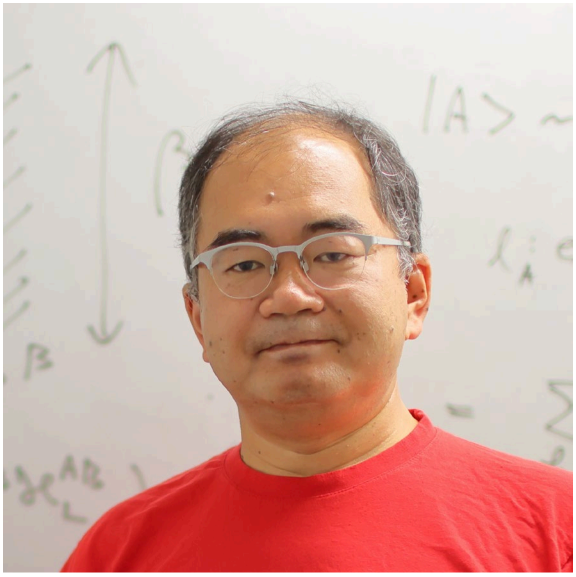

"Theoretical and mathematical studies of quantum spin systems"

Quantum spin systems have long served as basic models for describing the magnetic properties of solids. Since the 1980s, new developments have emerged from the viewpoint of topology in quantum many-body systems. The starting point was the celebrated Haldane conjecture, which proposed that the ground state of the one-dimensional antiferromagnetic Heisenberg model should depend qualitatively on whether the spin quantum number is integer or half-integer.

In 1987, Affleck, Kennedy, Lieb, and Tasaki introduced the AKLT model, a mathematically tractable variant of the S = 1 Heisenberg model. Through exact analysis, they demonstrated that its ground state is unique and gapped, thereby confirming the Haldane conjecture and providing a clear physical picture of the so-called Haldane phase [1]. It was further revealed that S = 1 spin chains exhibit fractionalized S = 1/2 edge spins — a hallmark of topological phases.

Dr. Tasaki subsequently introduced the non-local Kennedy–Tasaki (KT) transformation, showing that the ground state of the S = 1 chain possesses a hidden $Z_2 \times Z_2$ symmetry breaking [2]. Dr. Oshikawa extended this KT transformation to general integer-spin chains in 1992, discovering that the presence or absence of hidden symmetry breaking alternates depending on whether the spin is odd or even [3].

In the 2010s, Dr. Oshikawa, together with Dr. Pollmann and collaborators [4], established that odd-integer spin chains realize symmetry-protected topological (SPT) phases, thereby unifying the understanding of the Haldane phase. The series of works of Dr. Tasaki and Dr. Oshikawa not only deepened our conceptual grasp of the Haldane conjecture but also pioneered the field of topological phases of matter.

In parallel, Dr. Oshikawa extended the Lieb–Schultz–Mattis (LSM) theorem, which relates the spin quantum number and lattice periodicity to the existence of gapless excitations or degenerate ground states. In 2000, he succeeded in generalizing the LSM theorem from one-dimensional systems to higher-dimensional quantum many-body systems [5], providing a rigorous topological constraint on the possible ground states of quantum materials.

Through these mathematically rigorous and conceptually far-reaching studies, Drs. Tasaki and Oshikawa have made seminal contributions to the understanding of quantum spin systems and topological phases — achievements that have had a lasting impact on the theory of quantum many-body systems.

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