# Winning the 2026 Young Scientist Award of the Physical Society of Japan

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At the 2026 Spring Meeting of the Physical Society of Japan, held on March 24, I was deeply honored to receive the Young Scientist Award (Division 8: Strongly Correlated Electron Systems) for my work on *hidden fine structures in the thermodynamic probing of Landau quantization under high magnetic fields*. I am particularly humbled to be recognized within Division 8, a community that places strong emphasis on the fundamental understanding of correlated electron systems. This recognition is especially meaningful to me, and I would like to sincerely thank the selection committee and the colleagues who have supported my research over the years.

Landau quantization is a fundamental phenomenon in which a continuous electronic spectrum becomes discretized into Landau levels (LLs) under an external magnetic field. As the field strength varies, the singularities associated with these Landau levels periodically cross the Fermi energy, leading to oscillatory responses in a wide range of physical properties. These quantum oscillations are most prominently observed as the Shubnikov–de Haas (SdH) effect in electrical transport and the de Haas–van Alphen (dHvA) effect in magnetization. Since the first observation of SdH oscillations in bismuth in 1929, the study of quantum oscillations has developed into one of the most powerful approaches for probing the electronic structure of quantum materials.

In the early stage of my research career, I mainly used Landau quantization as a tool to investigate the carrier effective masses and excitonic properties of hybrid perovskites, an emerging class of semiconductors with considerable potential for photovoltaic applications [1]. Although the materials themselves were new and exciting, the underlying methodology remained largely conventional: Landau quantization was primarily employed as a diagnostic probe of electronic structure. During this period, I gradually began to wonder after nearly a century of research, **could there still be unexplored physics hidden within Landau quantization itself, rather than simply using it as a characterization tool?**

Motivated by this question, I turned my attention to quantum oscillations in thermodynamic probes, such as specific heat and the magnetocaloric effect, which had long remained relatively unexplored because of their limited experimental resolution. Previous studies of thermodynamic quantum oscillations were largely restricted to low magnetic fields far below the quantum limit, typically accessible only with conventional superconducting magnets. Against this background, I investigated the high-field thermodynamic properties of semimetal graphite and the Kondo insulator $YbB_{12}$ using high-resolution specific heat and magnetocaloric effect measurements in magnetic fields up to approximately 50 T. In both systems, I discovered previously hidden fine structures near the quantum limit, appearing as characteristic *double-peak features*, and developed theoretical interpretations for their origins.

In graphite, the double-peak structure that I observed could not be explained within the conventional Lifshitz–Kosevich (L-K) framework, the standard theoretical description of quantum oscillations. Instead, I found that this hidden fine structure originates from the Fermi–Dirac distribution function itself. Remarkably, the separation of the double peaks is directly linked to the electron effective mass and the Landé *g*-factor, allowing these quantities to be determined independently of conventional L-K analysis [2].

A similar double-peak structure was later identified in the high-field specific heat of the Kondo insulator $YbB_{12}$, a system that nominally lacks itinerant charge carriers. By combining magnetotransport, magnetocaloric effect, and specific heat measurements under high magnetic fields, I proposed that the observed thermodynamic oscillations may originate from charge-neutral fermionic excitations rather than conventional free electrons [3]. The microscopic origin of these unusual neutral fermions remains unresolved, although theoretical considerations suggest possible connections to composite excitons or Majorana fermions.

Looking back, what fascinated me most throughout these studies was not only the emergence of unexpected physical phenomena under extreme conditions, but also the realization that even in a field explored for nearly a century, fundamentally new questions can still emerge from careful thermodynamic observations.

Receiving this award is especially meaningful to me, as it marks an important transition from an eight-year postdoctoral journey to the next stage of my career as an independent researcher. I would like to express my deepest gratitude to my PhD supervisor, Prof. Duncan Maude, which has played an essential role in sustaining my curiosity and passion for research. I am particularly indebted to Prof. Yoshimitsu Kohama, whose trust, encouragement, and commitment to my research gave me the freedom to pursue unconventional ideas in high magnetic field physics. His support has profoundly shaped both my scientific career and my way of thinking as a researcher. I would also like to sincerely thank Prof. Atsuhiko Miyata for his invaluable mentorship in grant writing and laboratory management. My heartfelt thanks go as well to my close collaborators and dear friends—Prof. Amalia Patanè, Prof. Laurence Eaves, Prof. Christophe Marcenat, and Prof. Thierry Klein—for their longstanding collaboration and support. Finally, I am deeply grateful to ISSP for providing an outstanding academic environment that has witnessed my growth from a young researcher to an independent scientist.

**Reference:**


[1] Z. Yang et al., *ACS Energy Letters* **2**, 1621 (2017).

[2] Z. Yang et al., *Nature Communications* **14**, 7006 (2023).

[3] Z. Yang et al., *Nature Communications* **15**, 7801 (2024).


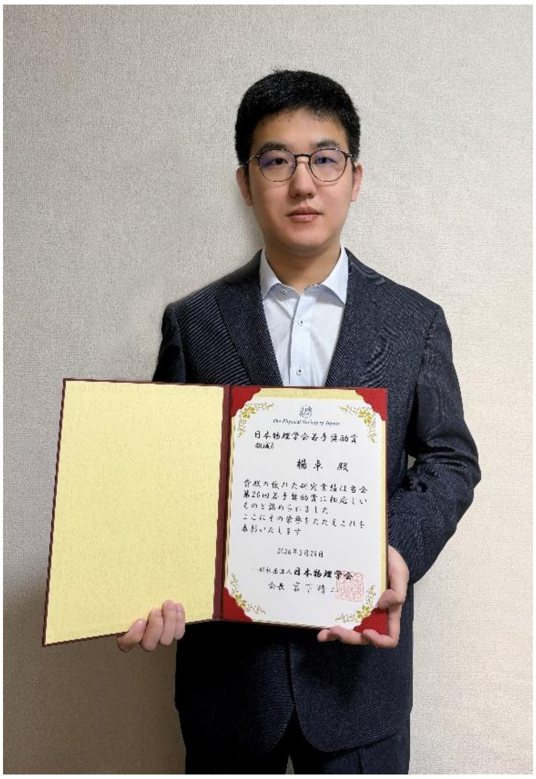


Fig. 1 Dr. Zhuo Yang with the certificate of the 2026 JPS Young Scientist Award.