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•Editorial•
Special Topic: Quantum Materials and Intelligent Devices
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Editorial

This special topic, comprising five articles, focuses on quantum materials and intelligent devices. Its aim is to provide researchers in relevant fields with a clearer perspective on recent breakthroughs in the unique physics of quantum materials and potential pathways for the future development of intelligent devices. In recent years, substantial research efforts have been dedicated to exploring controllable growth in two-dimensional (2D) quantum materials, leading to advancements in synthesis strategies that are essential for crafting high-quality intelligent devices [1]. By applying ultrathin ferroelectric materials in modern microelectronics, high-throughput in-memory computing application can be investigated by using the ferroelectricity to achieve multiple resistance states. Furthermore, their coupling with ferrovalley materials indicates the cross relationship between ferroelectrics and valleytronics, introducing an alternative route for optoelectronic neuromorphic application [2]. In addition, significant research efforts have been directed towards intelligent devices based on magnetic tunnel junction-based spintronic devices. This line of investigation explores the captivating physical phenomenon of tunneling magnetoresistance, which is closely tied to the functionalities of spintronic memristors and spin-torque nano-oscillators [3].

Quantum materials represent an enthralling frontier in scientific exploration. These materials, distinct from their conventional counterparts, are meticulously engineered to manipulate quantum states, pushing the boundaries of technological capabilities. Leveraging excellent properties such as high tunability, these materials enable the development of intelligent devices with rich functions and unprecedented information processing efficiency.

Beyond the widely studied ferroelectricity and magnetism, other highly tunable physical properties can also be exploited for developing intelligent devices. In this regard, ref. [4] highlights three fundamental categories of tunable properties in 2D materials: charge carriers, band structures, and lattice structures, which are integral to the general design principles of intelligent devices, particularly in the domains of electronics and optoelectronics. Another important category of physical phenomena continually attracting intense attention is strong electronic correlation. Ref. [5] reviews strongly-correlated electronic states including Mott insulators, quantum spin liquids, and Wigner crystals in emerging 2D materials, which would potentially spark inspiration for advancing next-generation high-performance multifunctional intelligent systems.

We would like to thank all the authors who have contributed to this special topic. We believe that the novel physics and promising directions proposed here will benefit the development of quantum materials and further strengthen the bridge connecting novel physics therein and artificial intelligence.

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