Engineering quantum technologies at the atomic scale

David D. Awschalom

Liew Family Professor, Spintronics and Quantum Information; Vice Dean for Research, Pritzker School of Molecular Engineering; Director, Chicago Quantum Exchange; The University of Chicago

Traditional electronics are rapidly approaching the length scale of atoms and molecules. In this regime, a single atom out of place can have outsized negative consequences and so scaling down classical technologies requires ever-more perfect control of materials. Surprisingly, one of the most promising pathways out of this conundrum may emerge from current efforts to embrace these atomic 'defects' to construct devices that enable new information processing, communication, and sensing technologies based on the quantum nature of electrons and atomic nuclei. In addition to their charge, individual defects in semiconductors and molecules possess an electronic spin state that can be employed as a quantum bit. These qubits can be manipulated and read using a simple combination of light and microwaves with a built-in optical interface and retain their quantum properties over millisecond to second timescales. With these foundations in hand, we discuss emerging opportunities and the importance of collaborating with industry to atomically-engineer qubits for nuclear memories, entangled registers, sensors and networks for science and technology.

Bio

David Awschalom is the Liew Family Professor and Vice Dean for Research in the Pritzker School of Molecular Engineering at the University of Chicago, a scientist at Argonne National Laboratory, and Director of the Chicago Quantum Exchange. He is also the director of Q-NEXT, a US DOE Quantum Information Science Research Center. Professor Awschalom is an experimentalist who works in spintronics and quantum engineering, studying the behavior of electrons, nuclei, and photons in semiconductors and molecules for quantum information processing. He is a member of the American Academy of Arts & Sciences, the National Academy of Science, the National Academy of Engineering, and the European Academy of Sciences.