



# 复旦大学物理系 物质科学报告

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## Si-based Quantum Computing - Physics and Technology

Seigo Tarucha

RIKEN Center for Emergent Matter Science & Tokyo University

To date basic techniques of implementing spin-based quantum computing have been developed using quantum dots, including single and two-qubit gates, initialization and readout. But improving the operation fidelity as well as increasing the qubit number is still a challenge in realizing fault-tolerant quantum computing. In this context electron spins confined to Si quantum dots have advantages because of the long decoherence time, longer than msec and the physical area per qubit is very small, smaller than  $0.1 \text{ um}^2$ . In this talk I will first discuss the spin dephasing measured for Si quantum dots and how to suppress it to raise the gate fidelity well exceeding the threshold of fault tolerant computation. I will then review the current research and development to scale up the qubit system, including integration technologies of the quantum processor and cryo-electronics to improve the performance of the large-scale quantum circuit.



Seigo Tarucha received the B. E. and M. S. degrees in applied physics from the University of Tokyo in 1976 and 1978, respectively. He joined NTT Basic Research Laboratories in 1978 and received the Ph. D degree in applied physics from the University of Tokyo in 1986. In 1998 he moved to the University of Tokyo as a professor in the Department of Physics and then to the Department of Applied Physics in 2005. In April of 2019 he retired from the University of Tokyo and moved to RIKEN Center for Emergent Matter Science (CEMS). He has been operating a Quantum Functional System research laboratory in CEMS since 2013

and also working as a CEMS deputy director since 2018. He was a guest scientist in Max-Planck-Institute (Stuttgart) in 1986 and 1987 and in Delft University in 1995. He is currently working on physics and technology in spin-based quantum computing and topological quantum computing as well. He received Japan IBM award in 1998, Kubo Ryogo award, The Quantum Devices award in 1998, Nishina award in 2002, National medal with purple ribbon in 2004, Leo Esaki Award award in 2007, and Achievement award of Japan Applied Physics Society in 2018.