PHYSICS
COLORADO STATE UNIVERSITY

# CSU PHYSICS COLLOQUIUM

## Why should we care about Topological Quantum Computer?*

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## Abstract

Today's computer has changed our world and social behavior since last century. These computers use 0 and 1 to perform computing in a **sequential** manner by fetching a memory and processing the information, known as Turing machine. As implemented in semiconductor technology, however, the computing performance has slowed down due to energy dissipation as the scaling of the size approaches the physical limit, in particular when handling big data, machine learning and information processing. The talk will present a general discussion on Today's von Neumann computers and neuromorphics systems. Quantum computer potentially offers a drastically different way of computing in a massively **parallel** using quantum bits (qubits). In contrast, the qubits are superimposed or entangled in the sense that 1 and 0 could not be taken apart. However, the superposition and entanglement need to maintain phase coherence, which is the key challenge for realization and for scaling up the number of qubits in quantum computing. Topological quantum computer protects the qubits and markedly increases the coherence time of superposition and entanglement, and thus makes possible scaling of qubits for solving many unsolvable complexity problems, including drug discovery, anticipation and prevention of natural disasters, e.g., earthquakes. By reducing 3 dimensional systems to two dimensions using Majorana particles as qubits, such topological quantum computer may be realized. In 1937, Ettore Majorana proposed a particle being its antiparticle. Since its inception, Majorana has been under intensive pursuit both theoretically and in experiments. I will discuss the quest and recent confirmations of Majorana by my group. Such kind of topological quantum computer using Majorana may enable new generations of computing and information processing.

[1]. Qinglin He, .. Kang L Wang, Science, V.357, Issue 6348, pp. 294-299 (21 July, 2017);

[2]. Hao Zhang, … Leo Kouvenhoven, Nature V.556, pages 74–79 (05 April 2018)

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**A short biography:**

Dr. Kang L. Wang is currently Distinguished Professor and the Raytheon Chair Professor in Physical Science and Electronics in the University of California, Los Angeles (UCLA). He is affiliated with the Departments of ECE, MSE and Physics. He received his PhD and MS degrees from the Massachusetts Institute of Technology and his BS degree from National Cheng Kung University (Taiwan) and. He is a Guggenheim Fellow, Fellows of American Physical Society and IEEE, and a Laureate of Industrial Technology Research Institute of Taiwan. He is an Academician of Academia Sinica. His awards include the IUPAP Magnetism Award and Néel Medal, the IEEE J.J. Ebers award for electron devices, SRC Technical Excellence Award, the Pan Wen-Yuan Award, IBM Research Award, and others. He served as the editor-in-chief of IEEE TNANO, editor of Artech House, editors for J of Spins and for Science Advances and other publications. His research areas include topological materials and physics; spintronics and nonvolatile electronics, and nanoscale physics and materials; low dissipation devices; molecular beam epitaxy.