Self-Assembly and self-organization for functionality design and advanced nano manufacturing

Kang L. Wang, PhD

Department of Electrical and Computer Engineering, Department of Physics and Astronomy, and Department of Materials Science and Engineering

University of California, Los Angeles, California

Abstract: Self-organization was initially proposed to address possible evolutions of machines but then led to the very important discipline of complexity theory, including self-assembly and dynamics phase transition. This discussion will first examine the physics of self-organization and self-assembly. The self-assembly in contrast with forced assembly (today's manufacturing) often addresses structure changes as driven by static interactions, while self-organization is referred to the change of order parameters as driven by dynamics, to affect functionalities leading to information processing (and memory). All these effects are based on interactions in close and open systems, and for the latter, it will enable the control of interaction types and strength. We will use the Ising model as an example to illustrate the self-organization of collective spins, making the spin texture change leading to skyrmions as topological quasi-particles. Self-organization may also appear in topological phase transition in both real and momentum spaces, which may be further explored for transformative quantum technologies. The ability to control the interaction in open systems is critical for the controllability of self-assembly, self-organization, adaptation and evolutions to construct functional blocks and units for IOT, which may adapt and evolve in 5G + XG networks according to the environmental change. The new advanced nano manufacturing may include the design art for programmable adaptive functionalities/energy. Thus, it is critical to engage new strategic research in understanding the fundamental of self-assembly and self-organization to determine the limits of sizes, variability, functionality and adaptability and to develop a new paradigm in adaptive systems. These new directions of research are exceptionally fertile grounds for material science research and will drive transformative technologies yet unforeseen

Bio: Dr. Kang L. Wang is currently a Distinguished Professor and the Raytheon Chair Professor in Physical Science and Electronics at the University of California, Los Angeles (UCLA). He is affiliated with the Departments of ECE, MSE, and Physics/Astronomy. He received his M.S. and Ph.D. degrees from the Massachusetts Institute of Technology and his B.S. degree from the National Cheng Kung University (Taiwan). He is a Guggenheim Fellow and fellows of the American Physical Society and IEEE. 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, and others. He served as the editor-in-chief of IEEE TNANO, editor of Artech House, editors for the Journal of Spins and Science Advances, and other publications. His research areas include topological insulators – condensed matters; spintronics/magnetics; Collective neurodynamics and cognitive intelligence; quantum nanoscale physics and materials; molecular beam epitaxy