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Superconducting supercomputer: Challenges and solutions

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In the time when semiconducting MOSFET-based electronics is reaching limits of its development, there is an active search for possible alternative technologies. One of them is superconducting electronics, with Josephson junction as a key electronic component. Superconductors offer several major advantages for creation of a future supercomputers. Perhaps, the most famous is the long-scale phase coherence, which enables observation of quantum-mechanical behavior in macroscopic objects. This allows fabrication of qu-bits for quantum computing with conventional micro/nano-electronic techniques. However, superconducting electronics offer also principle advantages for creation of an ultrafast classical (digital) supercomputer. The operation speed of a transistor is limited by the RC-time constant (R-resistance, C-capacitance). For semiconductors it is typically in a ns-range, limiting the operation frequency to the ~1GHz range. For superconductors with R=0 this limitation is lifted and the operation frequency can be inceased by more than two orders of magnitude to the sub-THz range with the corresponding increment of the operation speed. Another serious obstacle in semiconducting VLSIC's is overheating and removal of produced heat. This problem is particularly acute for supercomputers: the semiconducting exaflop (1018 floating point operation per second) computer would consume ~100MW power. Usage of dissipation-free superconducting electronics would provide a radical solution to this problem. Therefore, recently USA and China has initiated big research programs aiming at creation of such a computer with an exaflop speed. In this talk I will overview recent developments in research towards creation of a classical (digital) superconducting computer. The main focus of my talk will be on development of scalable random access memory for such computers, which remains one of the main unsolved problems.

Biography

Vladimir M Krasnov has completed his PhD at the age of 28 years from Institute of Solid State Physics, Chernogolovka, Russia and postdoctoral studies from Danish Technical University and Chalmers University of Technology, Sweden. He is the head of Experimental Condenced Matter Physics Lab at the Department of Physics, Stockholm University. He has published more than 100 papers in reputed journals.

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