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Fundamental physical capabilities and limitations in communication and computing

Fundamental Physical Capabilities and Limitations in Communication and Computing

Lev B.Levitin
Boston University, ECE Department, levitin@bu.edu

This talk is a review of sixty years of research focused on revealing the ultimate capabilities of physical systems, on one hand, and their fundamental limitations, on the other, in communication and computing. The following topics are considered.

1. Limits on information transmission by physical agents. Capacity and energy efficiency of photon and corpuscular channels. General bound on minimum energy per information unit.

2. The effect of irreversibility of quantum measurements. Entropy defect and "accessible" information.

3. POVM vs. von Neumann measurements in finite- and infinite-dimensional Hilbert spaces.

4. The maximum speed of computing operations. The Mandelstam-Tamm and Margolus-Levitin bounds. The minimum operation time of quantum gates. The unified tight bound on the rate of computation.

5. Thermodynamic cost of reversible computing. The minimum energy dissipation per computational step.

6. Equivalence relation between information and work. Heat-to-work conversion by use of one-particle and two-particle information.

Biography

Lev Levitin received his Ph.D. from the USSR Academy of Sciences in 1969. Currently (since 1986) he is Distinguished Professor of Engineering Science at the Department of Electrical and Computer Engineering, Boston University. His research areas include information theory, quantum communication systems, physics of computation, quantum computing, , mathematical linguistics, theory of complex systems, coding theory, reliable computer networks, and bioinformatics.

Levitin has published over 200 papers, presentations, and patents. He is a member of editorial boards of six scientific journals. Professor Levitin is a Life Fellow of IEEE, a member of the International Quantum Structures Association and other societies.

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