Momentum Computing Logical Gates

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ABSTRACT

Researchers at the University of California, Davis have developed a computing method that leverages potential energy barriers and momentum to perform logical operations with reduced latency and greatly reduced heat dissipation, while maintaining speeds at contemporary gigahertz rates.

FULL DESCRIPTION

Momentum-driven information processing involves initializing and manipulating potential energy barriers between information states in a device to induce momentum exchange, enabling a full range of logical operations. By establishing potential energy wells representing different information, temporarily removing the barrier imparts momentum that causes information to swap positions, followed by restoring the barrier to trap the data in new states. This method addresses limitations of traditional CMOS technology and adiabatic quantum flux parametrons by reducing heat generation by a factor of ten thousand, while maintaining high computational speed.

APPLICATIONS

- Next-generation low-power, high-performance computing devices.
- Energy-efficient digital logic circuits for integrated systems.
- Thermodynamic computing hardware that speeds AI learning and inference.
- Advanced processors in data centers and mobile platforms requiring thermal management.
- Specialized logical operation units in computing architectures.

FEATURES/BENEFITS

- Reduces computational heat dissipation by 10.
- Enables high-speed logic operations via momentum exchange by processing information stored in momentum.
- Improves performance by reducing latency relative to adiabatic state-control approaches.
- Supports multiple implementation formats (e.g., hardware devices and non-transitory computer-readable media).
- Mitigates excessive heat dissipation in miniaturized integrated circuits.
- Reduces energy–speed trade-offs caused by inefficient logical-operation methods.
- Overcomes thermal constraints that prevent further CMOS technology scaling.
- Reduces computational latency inherent in adiabatic quantum flux parametron logic.

INVENTORS

- Crutchfield, James P.
- Lyu, Jinghao
- Patten, Mathias V.
- Pratt, Christian Z.
- Ray, Kyle J.
- Tang, Kuen Wai

OTHER INFORMATION

KEYWORDS

adiabatic quantum flux parametron, computation, energy efficiency, heat dissipation, Josephson junction, logical operations, momentum-driven, potential energy barrier, superconductors, thermodynamic computation, momentum computing, low-energy computing, machine learning

CATEGORIZED AS

- **Computer**
  - Hardware
- **Materials & Chemicals**
  - Superconductors

RELATED CASES

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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Erasure-Flip Logic Gate for Momentum Computing

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