2023 Texas Symposium on Computing with Emerging Technologies (ComET)
University of Texas at Dallas
Session on Quantum & Superconductive Computing with Emerging Technologies

Touchpoints Between Classical Reversible Computing and Superconducting/Quantum

Wednesday, May 10th, 2023

Michael P. Frank, Center for Computing Research
with Rupert Lewis (Quantum Phenomena Dept.)

Approved for public release, SAND2023-____ PE
Some historical roots:

- Landauer’s limit (1961) follows from the unitarity of QM, and it motivates reversible computing.
- Konstantin Likharev’s reversible parametric quantron (PQ, 1977+) was one of the first efficient superconductive logic styles, and simultaneously one of the first concrete engineering implementation concepts for reversible computing.
- Richard Feynman’s early ideas about quantum computing (1982, 1985) were inspired by his interactions with Ed Fredkin, who always urged him to think about physics in computational terms.
- David Deutsch’s (1989) concept of quantum circuits was a direct generalization of Fredkin & Toffoli’s early (~1980) work on classical reversible logic circuits.

Current noteworthy intersection points:

- Yokohama National University’s adiabatic quantum flux parametron (AQFP) approach to superconducting logic can be viewed a modern successor to Likharev’s early PQ work
  - Includes a logically reversible logic family called reversible quantum flux parametron (RQFP), shown capable of circumventing Landauer’s limit in simulation. (And working test chips have been fabbed!)
- Recent work on ballistic models of superconducting reversible computing by groups at U. Maryland/LPS & at Sandia (& related theoretical studies by Jim Crutchfield @ UC Davis)
  - Heavily inspired by Fredkin & Toffoli’s 1980 billiard-ball model of ballistic reversible computing.
- Semiconducting/superconducting adiabatic/reversible logic can permit more energy-efficient control and readout in real engineering implementations of quantum computers!
  - E.g., see recent work by Erik DeBenedictis, zettaflops.org. (Slide shown during panel)