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THE CHARLES EDISON LECTURE SERIES

Creating the Quantum Computer

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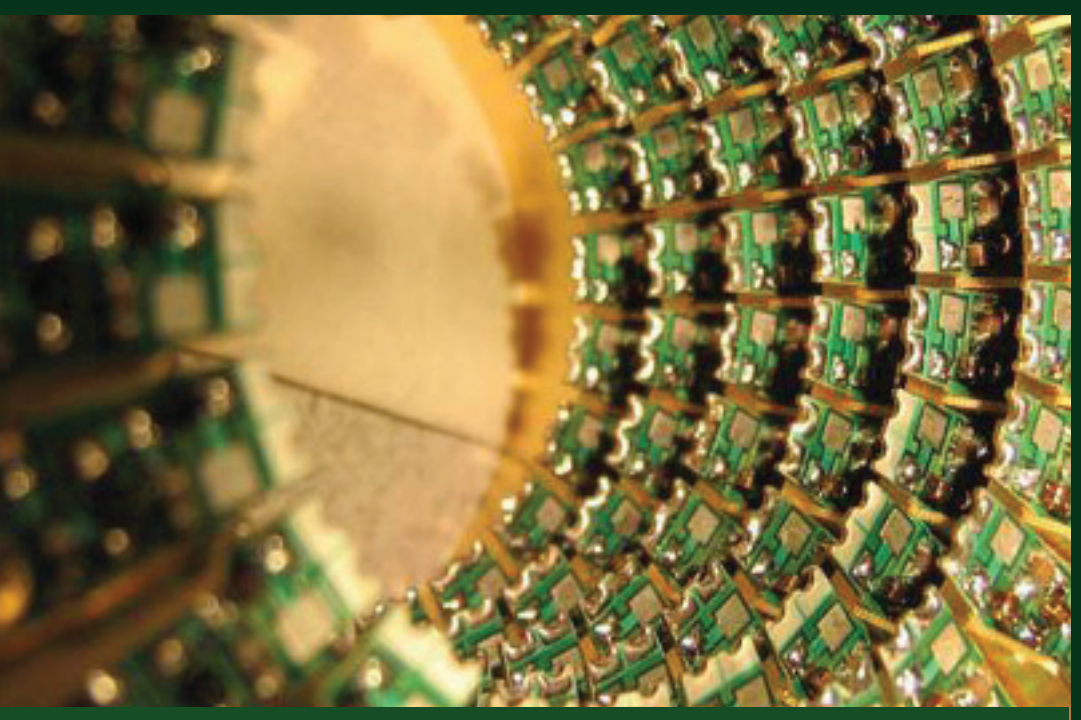

MICHAEL H. FREEDMAN

Director of Station Q, Microsoft Research
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Fields Medal (1986)
National Medal of Science (1987)

ABSTRACT

The underlying logic of our computers is of the 19th century. Computers might, instead, be designed to "think" in a quantum mechanical way. The tidal wave that brought us quantum mechanics may wash over us again 100 years later.

There is reason to believe that quantum computing is the ultimate mode of information processing consistent with physics. So the short answer to, "What will quantum computers do?" is, "Everything possible." Topology is geometry after you have forgotten local details; it deals with discrete structures. In physics local detail is usually of paramount importance. However one of the key physical ideas of the last 50 years – the "renormalization group" – tells us there are low temperature systems whose most important properties are topological in nature. The discrete nature of topology will allow us to control quantum mechanical evolutions in these systems with amazing precision. This is just what quantum computation requires.

BIOGRAPHY

Michael Freedman is Director of Station Q, Microsoft's Project on quantum physics and quantum computation located on the UCSB campus. The project is a collaborative effort between Microsoft and academia directed towards exploring the mathematical theory and physical foundations for quantum computing.

Freedman joined Microsoft in 1997 as a Fields Medal-winning mathematician whose accomplishments included a proof of the 4-dimensional Poincare conjecture, the discovery (with Donaldson and Kirby) of exotic smooth structures on Euclidian 4-space, applications of minimal surfaces to topology, and estimates for the stored energy in magnetic fields. Freedman has received numerous awards and honors: The Fields Medal, election to the National Academy of Science and the American Academy of Arts and Sciences, the Veblen prize, a MacArthur Fellowship and the National Medal of Science. His work since joining Microsoft has been primarily on the interface of quantum computation, solid state physics, and quantum topology.

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