BREAKTHROUGH IN QUANTUM COMPUTATION

INDRANI BOSE*

Editors' Note: *Classical Computers, from the humble PC to the laptops, notebooks, iPads to the supercomputers employ digital logic, circuits which deal with two-state logic, BITS 0 and 1. They sped up computation enormously upto* 10^{16} *floating point operations per second (10 petaFLOPs) and the fastest is that of Tianhe-2 which boasts 33.86 petaFLOPs (which is about a million billion times the 56 floating point operations per second of IBM 1620 made in 1961). Quantum computer works on a sequence of QUBITS and follows the principle of quantum mechanics which dominates any physical phenomenon in a sub-atomic scale.*

Quantum computers attempt at speeding up computations using superposition of QUBITS which are linear combination of quantum basis states and exhibit quantum entanglement. A single QUBIT can represent a 1, a 0 or any quantum superposition of these states $|1>$ *and* $|0>$*. In general a quantum computer with n QUBITS can be in arbitrary superposition of* 2^n *different states simultaneously whereas a classical computer can only be in one of these* 2^n *states at any one time. A quantum computer operates by manipulating those QUBITS with a fixed sequence of quantum logic gates determined by the quantum algorithm.*

Such QUBITS are realizable in several systems, e.g. by quantized magnetic flux tubes as in SQUIDs (superconducting quantum interference device). The main hurdle in building the quantum computers is in maintaining the coherence of the quantum states as you increase the size of the system. A new class of quantum computers utilizing quantum tunneling has been achieved (as pioneered by D-wave with their 128 superconducting logic elements). The idea of computation using quantum annealing technique was first mooted by a group of Calcutta based scientists. The history of a breakthrough is presented here.