Information, Science, and Technology in a Quantum World

About the Cover

A strange-looking cat welcomes you to the rich world of quantum research. Its sphere-like eyes represent the qubit, the quantum version of a classical bit. They point "up" and "down" in a quantum superposition, reminding us of Schrödinger's famous "cat para-dox." A cat is trapped in a steel chamber with a "diabolical device"—a flask of cyanic acid attached to a Geiger counter containing a tiny bit of very long-lived radioactive material. The decay of one atom will cause the contraption to shatter the flask and poison the cat. What is the quantum mechanical wave function of this system before we look inside?

It is a strange superposition in which the cat is dead and alive at the same time! Clearly, Schrödinger warns us not to ascribe too much reality to the wave function.

But perspectives change. Almost seven decades later, scientists are manipulating quantum superpositions in ways that make them seem almost tangible. In computation and communication, single qubits and multiple qubits are presenting new opportunities. One example is Peter Shor's famous quantum factoring algorithm. The beginning of the relevant quantum computing network is shown at the lower left. Another example is quantum cryptography, the new wave for communicating secret keys and a remarkable departure from the stone cipher wheel of long ago seen in the background.

At upper right is John Wheeler's drawing of the universe, a giant U, with the observer, a big eye, looking backward in time. The thin upper right end of the U represents the Big Bang, when it all started. Moving down, along the thin right leg, and up, along the thick left leg of the U, symbolically traces the evolution of the universe—from small to large. It is by observing single photons from the distant past that the early universe becomes part of our reality. In Wheeler's view, our reality ultimately derives from meas-urement of individual quanta—"it from bit."

(The drawing of the abacist at bottom right is used with permission from Cliché Bibliothèque Nationale de France, Paris. Permission for use of the confederate cypher wheel is from the Louis Kruh Collection.)

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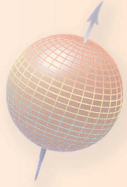
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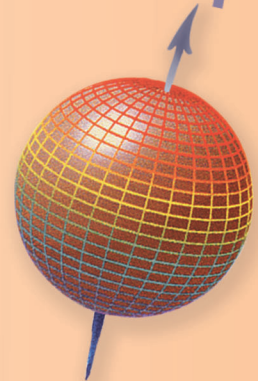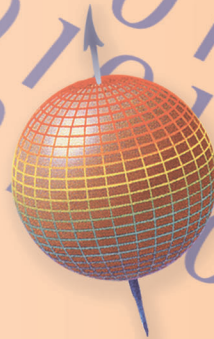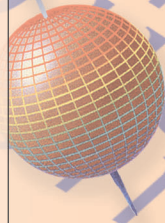
Concepts in Quantum Information Science

Quantum Science

Quantum Computation