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From Einstein's intuitions to quantum bits: amazing entanglement

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Abstract

In 1935, Einstein discovered entanglement, an amazing property of quantum mechanics which contradicted his world views. An intense debate with Niels Bohr followed, and was settled only after the discovery by John Bell of the famous inequalities named after him. Bell's theoretical work stimulated experiments, nowadays accessible to university laboratory classes, which demonstrate that entangled twin photons remain a single global object even when at a distance. We must take this conceptual revolution into account in our quantum description of the world. Applications of entanglement are also on the way, and a new field of research, Quantum Information, uses entanglement to develop applications as quantum cryptography and quantum computing. It may well be that we are living a second quantum revolution, which might change our society as strongly as the first quantum revolution did, when it gave us the laser and the transistor (and integrated circuits) at the root of the information and communication society.