Quantum supremacy: reality or myth?

We are not playing chess, we're playing roulette. Garry Kasparov

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Abstract

Calculation supremacy is expected for quantum computers operating with about 50 qubits. However, in case the non-classical 5D spacetime geometry-based theory (http://vixra.org/abs/1806.0181) of particle interactions is right, entanglement exists for the observer-bound coordinate systems only, thus requiring additional control. If so, quantum supremacy would be hardly achievable.

Classic computer simulations of a quantum circuit require an amount of time that scales up exponentially with the number of qubits leading to the estimation that about 50 qubits could be enough to demonstrate quantum supremacy [1]. Unfortunately, this ultimate goal is hard to achieve. Problems, such as decoherence and noise makes quantum computers much more error-susceptible than classical computers [2]. Moreover, the very fundamental theoretical basis of quantum computing, i.e. the understanding of entanglement may need a revision.

Under ideal conditions, a system of n qubits generates not $2n$ (like a classic computer), but 2^n eigenstates (quantum superpositions of the qubit states), which collapses into one of the most probable real states upon a physical measurement of the system parameters. The expectation is that in case the number of qubits is enough (i.e. about 50), the quantum system actually operating with 2^n eigenstates to overcome any classic computer system (at least for certain types of calculations). Indeed, 50 entangled qubits should have about $1.126 \cdot 10^{15}$ eigenstates, which is a few orders of magnitude more than the number of transistors in any modern computer chip. Presently, however, the number of operable qubits in any existing quantum computer is still far from this critical number.

Moreover, the very idea of quantum computing supremacy may appear questionable in case the fundamental understanding of particle interactions is revised. The idea of quantum computing is based on the quantum-mechanical understanding of entanglement, which is considered to be a natural property of elementary particles, impossible to be broken spontaneously (unless the particles interact with outside particles). However, according to the alternative theory of particle interactions [3] the entanglement is not a physical property of particles *per se*, it is an attribute of the chosen coordinate system. The non-classical 5D spacetime geometry-based theory [3] explains all the particle interactions with the spacetime geometry. It is postulated that the spacetime has a fractal structure ($S^3 \times S^1 \times S^3$) containing a compact spatial extra dimension governing electromagnetic interactions and three even more compact additional extra dimensions governing nuclear forces. If so, the particle interactions are background-independent *per se*, however, the descriptions are not, due to the necessity to operate with the physically inaccessible compact extradimensional geometry. The latter condition requires the theory to describe the extradimensional geometry not with any real field (like the Theory of General Relativity does), but with gauged complex fields (like Quantum Electrodynamics and Quantum Chromodynamics do). Notably, it requires the theory to operate with a special, observer-bound coordinate system, due to the necessity to treat separately the ordinary 3D space and the compact extra dimensions. Hence, the fact that the theoretical descriptions are not background-independent is not due to the particle nature, but the observational limitations. Thus, quantum phenomena, such as entanglement, tunneling, superposition, etc. are always bound to the coordinate system as well.

Let us examine an entangled particle from the positions of the non-classical 5D spacetime geometry-based theory [3]. An electron's movement in the global 4D space and absolute time (simplified model of the 5D spacetime) is governed by the geometry of the local space, S^4. The main alteration of this geometry is given by the extradimensional curvature, which the theory describes by a complex scalar field (like Quantum Electrodynamics does). In addition to this curvature (the origin of the electrostatic field), there is also some extradimensional torsional deformation. The electron's motion in S^4 can be approximated as having the two components: a "visible" movement in the ordinary 3D space, $\mathbf{R^3}$, and a "hidden" movement along the special extra coordinate. For the observer, the latter appears as a constant "invisible" spin along the microscopic round extra coordinate. This spin (the origin of the magnetic field) can have infinite possible directions in local 4D space (in S^4); for the observer, however, all those directions are reduced to just two, clockwise and counterclockwise (or "up" and "down"), due to the observer-required separation of the "visible" movement in $\mathbf{R^3}$ and the "hidden" spin along the microscopic S^1. Entanglement is one of the consequences of this artificial separation. When two particles are considered entangled, they remain the entanglement only in the observer-bound coordinate system where the original local space, S^4 is artificially "divided" into the two parts, $\mathbf{R^3}$ and S^1. In reality, however, there is no special direction on the microscopic scale, and the electron's motion is completely background-independent and never entangled.

In case the theory [3] provides an adequate understanding of the particle interactions, the entanglement cannot be considered a natural property of any physical system. Hence, a pair of particles that are entangled from the observer's view (as measured in an experiment) may not necessarily be entangled in reality, as no special direction (corresponding to the spatial extra coordinate) may exist at the microscopic scale. Thus, the entanglement is solely due to the observer-promoted choice of the coordinate system, and it must be additionally controlled during quantum operations. It is not clear how this requirement can be executed in practice, and even if it can, it is likely that the time and resources needed to maintain a system of 50 qubits entangled would be too high to achieve quantum supremacy.

References

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