Nine lives of the Schrödinger cat: Reality and quantum theory

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Outline

- Realism: what is absolute and what is relative?
- How do we observe?
- Quantum theory basics.
- Quantum computing.
- Some new results.
- Plenty of room at the bottom.
Realism: how do we observe?

Lengths, simultaneity are absolute.

Speeds are relative.

The world exists “outer there”.

It can be “observed” without disturbing it.

The accuracy of observation does not affect the system.

How about observing really tiny things?
Quantum Theory

Quantum: Time-evolution via Schrodinger equation.

“Probe-size” determines the behavior of outcome.

Until measurement, system in a superposition state.
Are classical computers enough?

http://qoqms.phys.strath.ac.uk

Not really!
If you want to factorize large primes.

Quantum computers: is it the answer?

In many problems, time or resources to solve $\sim$ exponential in size

Problems range across disciplines:

- Physics: interacting quantum systems
- Chemistry: molecular ground states
- CS: graph/network traversal
- Math: graph isomorphism problem
- Biology: photosynthesis efficiency

Use quantum “bits”

superposition = massive parallelization
QC: qubits and basic gates

Trapped atoms
NMR
Quantum dots
Superconductors
Photons

Reversible qubit gates
Controlled-NOT: interactions

So we have a photonic QC: what can we do?
How does a quantum simulator look like?

PT-Hamiltonian in a Unitary Simulator
Conclusions

Quantum world is “natural” at atomic level.
Quantum computers are the next big breakthrough.
Quantum computing is accessible to kids!

Thanks to kids:

PRA 83, 030103(R) (2010).
PRA 84, 024103 (2011).
PRA 84, 043826 (2011).
PRA 87, 044101 (2013).
PRA 89, 030102(R) (2014).

There is plenty of room at the bottom!
Boson sampling: use QC to solve!

M modes, N photons
Output distribution:
NxN permanent calculation

\[ P(F|I) = |\langle F|U(t)|I \rangle|^2 \propto \text{Perm}(U_{ij}) \]

Photon sampling in open PT systems?