Large scale qubit generation for quantum computing

July 27 2011, by Miranda Marquit

(PhysOrg.com) -- "Many people are trying to build a quantum computer," Olivier Pfister tells *PhysOrg.com*. "One to the problems, though, is that you need hundreds of thousands of qubits. So far, scalability has been something of a problem, since generating that many qubits is difficult."

Pfister is a physics professor at the University of Virginia in Charlottesville. Working with Matthew Pysher, Yoshichika Miwa, Reihaneh Shahrokhshani, and Russell Bloomer, Pfister is using quadripartite cluster entanglement in order to make a breakthrough in the scalability for the number of qubits available for use in a quantum computer. The work is presented in Physical Review Letters: “Parallel Generation of Quadripartite Cluster Entanglement in the Optical Frequency Comb.”

“There are several ways to make qubits with light,” Pfister explains. “One is to use a resonant mode of a cavity. A single laser cavity has millions of harmonic modes, and if you can design it, your scalability problem is solved.”

The team at the University of Virginia made use of an optical frequency comb in their design to emit light fields that to be used as qubits. “We excite a great number of them. These are Qmodes, and can be used as qubits. I can control where I put them, and then also entangle them,” Pfister says. “We use a two-photon emission medium, putting one photon in a given frequency, and the other in another. The Qmodes are well separated in frequency."

Since the set up allows for entanglement, it is possible for Pfister and his colleagues to create a cluster entangled state designed especially for quantum computing. "Our design has correlations for all the qubits, and you can do measurements on them and implement quantum gates for one-way quantum computing," Pfister says.

Pfister points out that quantum computers of this sort cannot actually replace classical computers. However, quantum computers can be used for processing some types of information faster. "This is an attractive model for experiments that need cluster states. The big deal is that we got all these little quantum registers, and the entanglement is remarkably consistent."

The next step, Pfister says, is to entangle the already-entangled qubits into a bigger register. "It requires additional complexity to entangle them all together, and we're on our way to this. We have shown that our control of entanglement is pretty good, but we need even better control to make entangled sets bigger than four."

Pfister thinks that the results of this experiment will result in increased interest in Qmodes of light. "People will start thinking differently about Qmodes of light," he says. "We are driving the field, and hopefully we'll make them on a single large scale, rather then make many small scale ones. Once that happens we will be ready to start with quantum processing."

"There are a lot of tools available right now to make qubits, and this is one of them," Pfister continues. "Our experiment shows a great potential for scaling up the number of entangled qubits that can be used in quantum processing. We are another step closer."

More information: Matthew Pysher, Yoshichika Miwa, Reihaneh Shahrokshahi, Russell Bloomer, and Olivier Pfister, "Parallel Generation of Quadripartite Cluster Entanglement in the Optical Frequency Comb," *Physical Review Letters* (2011). Available online: link.aps.org/doi/10.1103/PhysRevLett.107.030505

Copyright 2011 PhysOrg.com.
All rights reserved. This material may not be published, broadcast, rewritten or redistributed in whole or part without the express written permission of PhysOrg.com.

Citation: Large scale qubit generation for quantum computing (2011, July 27) retrieved 23 April 2024 from https://phys.org/news/2011-07-large-scale-qubit-quantum.html

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.