Taking entanglement beyond one ebit

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"Entanglement is a main part of quantum mechanics, and it is important to obtain a high degree of it in physical systems," Lucas Lamata tells *PhysOrg.com*. Lucas Lamata is a scientist with the Institute for Fundamental Mathematics and Physics, CSIC, in Madrid, Spain.

His two collaborators are J.J. García-Ripoll and J.I. Cirac at the Max Planck Institute in Garching, Germany. They propose a way in which to take entanglement beyond its current limit of one ebit. Their Suggestion is titled "How Much Entanglement Can Be Generated between Two Atoms by Detecting Photons?" and appears in *Physical Review Letters*.

Entangled atoms are important to quantum information processing, and many groups are working to create models of quantum computers and efficient methods of entanglement. Different schemes for quantum information processors and quantum networks are appearing all over the world. The idea is to find the best way of transmitting quantum information over distances from one place to another. "Keeping coherence when the atoms get entangled" is of the utmost importance Lamata points out.

However, even though photons are considered ideal for this job, they are not particularly good for storing information. Atoms, on the other hand, can preserve quantum information in storage for much longer times. Lamata and his colleagues believe that photonic channels connecting a network of atomic (or even solid-state) devices will be the best way to achieve a quantum network. And this means a better method of entanglement is needed. A method that better preserves quantum information.

Lamata and his colleagues focus on the entanglement between two atoms for their theory. Most experimental entanglements are based on entangling atoms separated by distance are based on one of two methods: photon emissions from one atom interacting with the second atom, and measuring the state of the photons emitted by both atoms. However, Lamata explains, most of these experiments deal with “entangling the polarization of the photon with the internal state of the atom. This is finite, so one cannot obtain more than one entanglement bit or ebit. This is inefficient.”

Lamata and his coauthors suggest a new way to entangle these atoms. Their proposal considers more than just the internal state of the atoms. “We thought that by considering various things, like momentum, it would be possible to do more entanglement.” And this would expand the entanglement beyond the current excepted maximum of one ebit. “This is a bipartite system, and similar to the method of using photons emitted by both atoms. But we consider other possibilities that have not been seriously considered yet.”

According to Lamata, this suggestion is not something that has to be put off until the future brings with it different technology. “We are not experimentalists,” he explains, “but we already have feedback from experimental groups that say they are interested in doing this.” The suggestion posed by Lamata and his colleagues might offer the possibility of making quantum information processing progress in the near future. Lamata insists: “This is something that can provide more efficient entanglement. With this proposal, we thing that it is attainable today.”