On the Impossibility of Keeping Out Eavesdroppers Using Only Classical Physics

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When someone attempts to sneak in an observation on an entangled set of particles in the here-and-now, the quantum result looks just as if a record of that transgression was captured, sent back in time to the original generation of the entangled particles, and then rebroadcast for everyone in the future to see.

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This is about: Quantum encryption, Quantum entanglement, Quantum correlations in quantum information

I. THE KISH CLAIM

This paper [1] by Dr Laszlo Kish of Texas A&M, which is discussed [2] by Bruce Schneier of Counterpane Internet Security, asserts in effect that the authors have developed a classical method of encryption that is superior to quantum methods. That's a very interesting claim. However, instead of diving directly into the details of the Kish paper, let's take a look at it from a different perspective: What is it, exactly, that makes quantum communications different from classical?

II. A QUICK METHOD FOR UNDERSTANDING ENTANGLEMENT

The peculiar thing about observing one half of an entangled pair of particles is that as soon as you look at either one of them, from that moment onward they both behave as if you had somehow reached back into time and forced the original generation of the pair to match up to how you did your observation.

Suppose, for example, that you choose to look at one of the two particles using an ideally engineered vertical polarizer. If you subsequently look at the other particle with a similarly perfect polarizer with the same orientation (that is, vertical), it is 100% certain that the second particle will also be vertically polarized [3].

Notice that probability: 100%. That is, not all aspects of quantum entanglement are probabilities. In the right situations, simple but baffling certainties pop out.

III. UNDERSTANDING THE EFFECTS OF DETECTION

In this case, what is particularly perplexing is that you will always get a correct result if you interpret the situation in the following physically impossible but mathematically consistent fashion. Imagine that when you test the first particle with a vertical polarizer, the "vertical" part of your test method travels backwards in time and resets the original generation of the entangled pair, exactly as if the two particles had been generated in a vertical polarization in the first place.

The "as if" is an important qualifier! The reason such a mental model of the event is guaranteed to work is that *entanglement by definition can only occur if the original event never left any record of what happened* [4]. Thus in this way of looking at quantum events, you can change the past only when it is guaranteed that no one else in the universe knows what that past was. Problems of causality violation thus are avoided, making this little change-the-past analysis a convenient short hand for understanding how entangled particles are affected when one of them is observed.

The nice thing about this visualization is that it provides a fairly vivid way of understanding why it's so hard to be sneaky in quantum communications. The problem is this: When someone attempts to sneak in an observation on an entangled set of particles in the here-and-now, the quantum result look just as if a record of that transgression was captured, sent back in time to the original generation of the entangled particles, and then rebroadcast for everyone in the future to see.

It's a bit like breaking into a store today, only to find out that last week the store had already shipped out a video of you doing it to every police station in the area.

That sort of thing makes stealing... tricky, and in a much

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more fundamental way that just putting stronger bars on your windows.

IV. BACK TO KISH

So, why do I bring this up in response to the Kish paper, which claims to have found a classical mechanical method that is just as reliable as quantum cryptography?

Very simple: Unless Kish can explain how he too manages to provide the mathematical equivalent of resetting a past event in a way that communicates itself to everyone listening in the future, I would say he is most likely doing the cryptographic equivalent of inventing a perpetual motion machine — you know, one of those devices that claims through clever, often elaborate methods to create a machine that violates one of the fundamental principles of physics, such as conservation of energy. The problem is that since classical phenomena are by definition observed phenomena already firmly embedded in the known past, they cannot possibly capture that remarkable feature of resetting the past that is the distinguishing feature of quantum communications security.

V. CRYPTOGRAPHIC PERPETUAL MOTION

So, while I for one certainly could not say without a lot more study where the flaw is in Kish's paper, I will nonetheless state with what I consider to be a very high degree of certainty that the flaw is there — that is, that the Kish method will ultimately prove to be some sort of very clever cryptographic perpetual motion machine. Like a well-oiled wheel that spins for a very long time, it is probably very good encryption, and I would not be surprised that has some great uses. But if the paper really does mean its claims of providing the same levels of protection as quantum methods while using only classical physics: No, it will not spin forever, and it will not be able to provide the same level of absolute security.

VI. ADDENDUMS

1. Feb 9, 2006. A commenter in Bruce Schneier's blog on this paper mentioned speed-of-light issues. This sounds to me like a good starting point in looking for flaws in the Kish paper. It is possible, for example, that the Kish method can provably lock out eavesdroppers only if some type of desirable signal can be assured always to propagate before an adversarial signal.

[1] L. B. Kish, "Totally Secure Classical Communication Utilizing Johnson (-like) Noise and Kirchoff's Law," *Physics Letters A*, vol. 352, p. 178–182, 2006. https://arxiv.org/abs/physics/0509136

[2] B. Schneier, "Totally Secure Classical Communications?," *Crypto-Gram Newsletter*, 15 December 2005. https://www.schneier.com/crypto-gram/archives/2005/1215.html#15

[3] R. P. Feynman, R. B. Leighton and M. Sands, The Feynman Lectures on Physics, Volume III: Quantum Mechanics, vol. 3, Caltech, 1963. https://www.feynmanlectures.caltech.edu/III_toc.html

[4] R. P. Feynman, QED: The Strange Theory of Light and Matter, Princeton University Press, 1985.

VERSION HISTORY

Ver.	Date	Changes
2.0	Oct 30, 2021	Reformatted for publication in TAO Physics
1.1	Feb 9, 2006	Reformatted; minor fixes; history added; addendum section added
1.0.1	Jan 31, 2006	Reformatted; typo fixes; added refs; added email address; made PDF
1.0	Jan 23, 2006	First list-server version