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Is spooky action-at-a-distance a misnomer?

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Will look at an article that has the opinion that spooky action-at-a-distance is a misnomer. The article seems to have that opinion because it wants to deny the possibility that our understanding of physics based on special relativity is wrong. Rather than accept special relativity as wrong, its supporters try to find excuses.

Tom Siegfried [1] tells us [2]: "As one leading quantum expert, IBM's Charles Bennett, has said, what Einstein got wrong was characterizing entanglement as spooky action at a distance. "It's spooky," says Bennett, "but it's not action at a distance.""

The claim being made in that article is that people going by Einstein and calling "quantum entanglement" as "action-at-a-distance" have got it wrong; it's a misnomer.

There seem a lot of terms in physics that have been misnamed (but I will pass about going into details about that).

The article starts: "A couple of weeks before last Halloween, physicists in the Netherlands treated the physics world with experimental proof of what Einstein called "spooky action at a distance.""

So, the claim is that spooky action-at-a-distance has been experimentally confirmed even though the term itself is a misnomer, and if you didn't know it was a misnomer you would interpret the concept wrong.

The article then goes on to refer to spooky action-at-a-distance as quantum entanglement:

"It's not the first time experiments have demonstrated the spooky phenomenon, known as quantum entanglement. But this experiment closed some loopholes cited by skeptics who hoped that entanglement would turn out not to be so spooky. The verdict is in, and spooky wins. Measuring a property of one entangled particle can tell you what measuring the other particle will reveal. No matter how far away the other particle is."

Then comes revisionism:

"Einstein didn't like it. But both the nature of his objection and what this experiment really showed have been widely misreported."

So, the claim now is that is commonly reported about this is wrong, and says if you went by that then you were misled:

"If you've read about this result in popular media (such as newspapers and newsmagazines containing the word "Times" or "Time"), you might want to consider getting one of those Men in Black memory erasers. You have been misled."

This is how crazy physics gets; what people might commonly believe about some bit of physics might be completely wrong.

He goes on to give an example of misreporting:

"One newsmagazine's story, for instance, carried a headline screaming "What Einstein got wrong about the speed of light." And a major newspaper reported that the new experiment proved "that objects separated by great distance can instantaneously affect each other's behavior." In fact, Einstein got nothing wrong about the speed of light, and entangled objects do NOT instantaneously affect each other."

And then he gets to saying what I first quoted at the beginning of this article:

"As one leading quantum expert, IBM's Charles Bennett, has said, Einstein got wrong was characterizing entanglement as spooky action at a distance. "It's spooky," says Bennett, "but it's not action at a distance.""

Then some more revisionism:

"It is also sometimes incorrectly reported that Einstein didn't believe in entanglement or that he thought quantum theory must be wrong because of it. Einstein did not argue that entanglement couldn't happen. He believed that the quantum description of nature was accurate with respect to what could be observed. He just thought that entanglement suggested the existence of hidden “elements of reality” that quantum math did not account for. So while Einstein didn’t think that quantum mechanics is wrong, he did contend that it is incomplete — that it didn’t tell the whole story.”

So, we have the wordplay that saying, ‘a theory is wrong’ is not the same as saying ‘the theory is incomplete’. Some people do interpret both such statements as really meaning the same thing. When people can interpret in their various ways this can lead to confusion on such issues as ‘a theory is wrong’ versus ‘theory incomplete’.

Anyway, after brief mention of experiment, he gets on to admitting there is still a mystery:

“Sure, there’s still a mystery here. Physicists have argued about entanglement for decades; they offer all sorts of different points of view, explanations and arguments about what it means and what its consequences are for understanding the nature of physical reality.”

So, there is not agreement about entanglement thus highlighting it is only really been his point-of-view about “spooky at-a-distance”. He is dismissing articles that do not conform to his point-of-view as being wrong.

He continues:

“Nevertheless much that is written about the subject is just confused. Expert quantum physicists actually do have a good grasp on how it works, even if there’s some debate about why it works the way it does. But let’s face it, entanglement is complicated — it’s quantum physics after all — so explaining it requires more context than most accounts are usually able to offer. So let’s start with what entanglement is and why Einstein didn’t like it.”

For the rest of what he thinks see the remainder of his article; which I don’t necessarily agree with.

He has a part 2 to the article [3] which gets interesting in places.

“Until his death in 1955, Albert Einstein hoped that someday science would do away with what he called spooky action at a distance.”

Which dealt with in part 1 as that concept being a misnomer. Siegfried doesn't clarify if Einstein knew it was a misnomer.

"His [Einstein's] concern was quantum entanglement. Two entangled particles, even after traveling very far from one another, share a mysterious quantum connection. Measuring one tells you instantly what the outcome will be of making the same measurement on the other. If Alice's quantum coin turned up tails, for instance, then she knows that Bob's coin will show heads, wherever he is, whenever he looks at it."

The experimental setup had been described in part 1 as: "Suppose you prepared entangled photons and sent them to Alice and Bob in such a way that if Alice measured hers to be vertically polarized, she instantly knows that Bob's will be horizontally polarized." Now treating that as if it were "quantum coins".

"To Einstein, that seemed possible only if the distant particle had acquired its property when the particles last encountered each other. (In other words, the reality of the property was determined "locally.") So Bob's coin would be locked into "heads only" when his and Alice's coins parted ways. In Einstein's view, both coins (or particles) possessed definite properties for their entire trip. But the math of quantum mechanics demands otherwise. In the quantum realm, particles do not possess precise properties until measured. A quantum particle's spin axis, for instance, points neither up nor down until you measure it (like a spinning coin that is neither heads nor tails until you catch it)."

"But even if measuring a particle establishes a property that didn't previously exist, Einstein wondered, how could measuring the spin of one particle here tell you what the spin of the other one will be far away? He could not fathom that a property measured at one location could suddenly cause a property to come into existence for a particle somewhere else. He concluded that quantum mechanics was simply incomplete. Einstein believed that a deeper theory, incorporating unobservable "elements of reality," would explain the mysterious long-distance entanglement connection."

"But Einstein's intellectual adversary, the Danish physicist Niels Bohr, argued that nature does not conceal such a theory. Even before entanglement had been articulated as an issue in quantum physics, Bohr had perceived that Einstein's desire to understand cause-and-effect in terms of spacetime pictures was doomed. In the quantum realm, you cannot construct both a cause-and-effect account of a process and a spacetime description of that process. Those views are mutually exclusive; one is complementary to the other.”

It sounds crazy now saying “spacetime pictures was doomed”- there is nothing picking up from that in mainstream physics literature that I know of.

Then the next bit seems incomprehensible:

““The very nature of the quantum theory,” Bohr said, “forces us to regard the space-time co-ordination and the claim of causality … as complementary but exclusive features.””

No idea what that is supposed to mean, and the next bit does not help:

“So when you ask how a measurement of Particle A (at one point in spacetime) “causes” something to happen to faraway Particle B, you are mixing up a spacetime description with a cause-and-effect description. That’s precisely what quantum physics does not allow, Bohr asserted.”

So, what is he saying (?) – that relativity is wrong on this issue; I doubt that relativists would agree; even I don’t agree with him, and I criticise relativity a lot.

“And all the experimental evidence, including several new experiments closing possible loopholes in Bohr’s arguments, supports his view.”

Sounds like just trying to impose a crazy subjective interpretation onto the experiments.

“Understanding entanglement, it now seems, will require an even more radical insight into the interplay of space, time and reality than Einstein had imagined. It will take more than a new, more comprehensive theory. It will require a new perspective on the foundations of existence itself.”

Then we get to a section he calls “Dashing Einstein’s hope”:

“While Einstein was alive, his hope for a deeper theory seemed reasonable. As long as such a theory made all the same predictions for experimental outcomes that quantum mechanics did, then no experiment could contradict Einstein’s intuition. But in 1964 the Irish physicist John Bell devised a test that actually could tell the difference between standard quantum theory and one that explained away the spooky part. In the decades since, numerous experiments have exploited Bell's insight to demonstrate that quantum entanglement is every bit as spooky as Einstein feared: There are no hidden bits of reality that act "locally" to predetermine quantum measurement results."

The relevant word is "locally", so its not "local" but instead "non-local."

"But for some reason physicists and philosophers (and a lot of other people) can't quit arguing over what it all means."

i.e. still arguing over interpretation. Siegfried has been presenting his personal interpretation for most of this article giving the impression it is the only interpretation, when really how to interpret the experiments is still be argued over.

And they are not agreeing as he admits:

"About the only thing everybody agrees on is that in all entanglement research the two experimenters are named Alice and Bob."

Getting to the next point of relevance:

"Bell's theorem proved that there's a limit to how often Alice's and Bob's results would match if nature provides preexisting values for any measurable property (as Einstein believed). The standard quantum view (particle properties are not determined until they are measured) predicts that Alice and Bob's matches can exceed that limit. And that's what always happens."

"Until recently, though, Einstein sympathizers could point to loopholes in the experiments. Perhaps nature was concealing some secret signaling system that alerted the particles (or the devices detecting the particles) in advance, so they could coordinate their results. Or perhaps the detectors (not being perfectly efficient) recorded particles selectively, somehow conspiring to preserve the illusion of spookiness."

"But new experiments have closed those loopholes. Detectors have been set up far enough away so that no secret signal (respecting the speed of light limit) could have been transmitted fast enough to affect the results. And high-efficiency detectors (or high-efficiency experimental design) have eliminated the loophole of selective sampling. By showing that Bell's matching limits are violated, these experiments rule out theories that preserve "local realism.""

The relevant issue is “respecting the speed of light limit” that is what he is calling “local realism” (?) There are theories that are non-local, in which case allowing faster than light “secret signalling”. It all goes back to special relativity, where many people think it imposes a speed limit c, and I have dealt a lot with why I think there are a lot of mistakes in that. (In my other articles.)

He then gets onto the issue of “nonlocality”:

“As some reports described them, the new experiments therefore establish “nonlocality” as a feature of nature. And some physicists do describe the results in that way. But whether the principle of locality is actually violated — implying nonlocality — is a complicated question. As physicist Leonard Susskind (with Art Friedman) writes in *Quantum Mechanics: The Theoretical Minimum*, “Nonlocality is surprisingly difficult to even define.””

Far as I am concerned it is fairly easy to define: there are a lot of mistakes with special relativity.

“In fact, Susskind writes, Einstein’s notion and Bell’s notion of nonlocality seem to differ.”

That is a big problem, but again most of the problem is mistakes in special relativity.

“But in any case, in entanglement experiments no “influence” is being transmitted from one particle to another when one is measured. It’s just that measuring one provides knowledge about what the outcome of measuring the other will be.”

I think what is meant is: that signalling is not being measured as it happens, only measured after it has happened.

“It’s especially wrong to suggest, as some accounts have, that one particle’s measurement “instantaneously” determines the other’s. There is no such thing as “instantaneous” for particles separated in space.”

In Newton’s theory of gravity there is instantaneous action-at-a-distance, so that is an example of a theory that allows it; so the claim: “There is no such thing as “instantaneous” for particles separated in space.” – is false in the context of theories; there are theories which would allow it, and if it were true then many peoples’ understanding of special relativity as not allowing “instantaneous” either means their understanding is false or special relativity is wrong.

“As Einstein’s own relativity theory demonstrates, from different points of view Alice’s measurement could appear to happen either before or after Bob’s.”

By this he is just trying to justify his rejection of “instantaneous” by his belief in special relativity, so fallacious circular thinking.

After rejecting the possibility that special relativity is wrong, he then wonders what is going on:

“So if no signal is telling these particles how to coordinate their results, what’s going on?”

And the next question he asks highlights the absurdity:

“And why so much confusion about it?”

There is no confusion if decide the rejection of “instantaneous” is false, and special relativity is false. The confusion comes from trying to still hold onto special relativity inspired belief that there is no “instantaneous.”

So, now he goes onto his confused attempt an answer:

“The answer involves the great difficulty in comprehending how profoundly quantum physics has reconstructed ordinary human conceptions of reality. Common sense, for instance, suggests that the whole is the sum of its parts. But entanglement illustrates a quantum reality in which a known whole consists of unknown parts. For an entangled pair of particles, the quantum math offers complete information about the whole entangled system, but provides no information about either entangled particle.”

Basically, what he is trying to do now is reject “common sense”.

““In quantum mechanics, we can know everything about a composite system — everything there is to know, anyway — and still know nothing about its constituent parts. This is the true weirdness of entanglement, which so disturbed Einstein,” Susskind writes.”

“Whether this state of affairs constitutes “nonlocality,” though, depends on what nonlocality means. In one of the new entanglement papers (in *Nature*), Bas Hensen of Delft University of Technology and collaborators wrote that “local” means that “physical influences do not propagate faster than light.””

Which would be the simple solution, but then Susskind wants to confuse things:

“But in the Bell experiments, as Susskind emphasizes, there is no signal from one particle to the other;…”

People disagree with lots of things in quantum mechanics, there must be many who disagree with Susskind’s belief on this.

The reasoning for believing “no signal” is:

“Bob’s quantum description of his particle remains unchanged even after Alice measures it. Bob will know Alice’s result (or vice versa) only after communicating with her via ordinary slower-than-light channels, like texting.”

But how is it determined that “description of the particle remains unchanged even after Alice measures it” – that would involve knowing/measuring the particle before it was measured to know what its state was before and after measurement, which they can’t do! So, they are just trying to impose an absurdity onto the situation.

Anyway, after falsely concluding:

“So despite some news accounts to the contrary, there is no faster-than-light signaling in entanglement.”

It then decides:

“In violating Bell’s idea of local realism, it’s the “realism” part that quantum mechanics challenges.”

i.e. it has rejected non-locality as to the reason there is no “local realism” and has to now attack “realism”.

“As Hensen and colleagues define it, realism means that “physical properties are defined prior to and independent of observation.” Apparently, they’re not.”

“Murray Gell-Mann, the Nobel laureate physicist famous for conceiving (and naming) the particles known as quarks, has worked extensively on the foundations of quantum mechanics in recent decades. In his view much of the confusion stems from trying to apply classical (prequantum) physics to a quantum mechanical system — or a quantum mechanical universe. Experiments violating the Bell matching limit, Gell-Mann once told me, have no need for nonlocality.”

““It’s not nonlocal at all,” he said. “There’s nothing being propagated from this detector to that detector, it’s just that if … they’re entangled, if this polarization over here is determined, then the polarization over there is determined, because of the entanglement…. It’s got nothing to do with something passing from here to there. There’s nothing passing.””

“In Gell-Mann’s view, the problem stems from forgetting that the universe as a whole is itself quantum mechanical. That requires that the math describing it incorporate multiple possible “realities” — a vast number of possible chains of events, each chain being a “consistent history” that approximates a reality that (if you don’t look too closely) seems classical.”

It is interesting to note that it is his (Gell-Mann’s) “view”, suddenly we are back to talking about peoples’ different viewpoints. And then we get the “argument”:

“Whether all these “quasiclassical” realms of existence actually exist or not remains a lively argument.”

The “argument” being over these different viewpoints.

“Perhaps they constitute multiple real universes, or perhaps they just catalog all the possibilities that nature chooses from. Either way, quantum entanglement merely reflects the fact that different measurement results occur in different branches of quantum histories. When Alice measures her particle, she finds out which branch of history she is in, and therefore also knows what Bob’s result will be.”

The next comment sounds like a joke:

“If it had been explained that way to Einstein,” Gell-Mann said, “he might have accepted it.”

After everything said, the article is now trying to appeal to the authority of Einstein (via Gell-Mann) and suggest he might have accepted this view.

“Whether accepting it or not, Einstein would have been intrigued. And he would have been more intrigued by some of the latest research attempting to understand spacetime itself — Einstein’s specialty — in terms of quantum entanglement. Physicists have recently been pursuing a line of reasoning by which spacetime is “constructed” from networks of entangled quantum states. Somehow, the quantum states describing basic particles generate webs of entanglement that correspond in some way to the geometry of spacetime itself.”

The article then just ends up in gibberish as far as I am concerned:

““The intrinsically quantum phenomenon of entanglement appears to be crucial for the emergence of classical spacetime geometry,” Mark Van Raamsdonk of the University of British Columbia argued in a 2010 paper.”

“If this approach, which many physicists regard as promising, proves fruitful, then the weirdness of entanglement has an obvious explanation. Entanglement can’t be visualized in spacetime terms because entanglement precedes spacetime. You need entanglement to have spacetime — it is somehow more fundamental than spacetime. So you cannot understand entanglement as something that happens within spacetime.”

“This strikes me as very close to Bohr’s original insight, first articulated in 1927, that a spacetime description and a cause-and-effect description are mutually exclusive. Almost nine decades later, physicists may be on the verge of understanding why those two views are incompatible, and may soon be able to show that entanglement itself provides the resolution of its own mystery.”

The article has been written trying to put forward that there is only one point-of-view and dismissing other points-of-view about quantum entanglement such as this one [4]:

“A team of Chinese physicists have clocked the speed of *spooky action at a distance* — the seemingly instantaneous interaction between entangled quantum particles — at more than four orders of magnitude faster than light. Their equipment and methodology doesn’t allow for an exact speed, but four orders of magnitude puts the figure at around 3 trillion meters per second…."

And goes onto say:

"A lot of work is being done in this area, though, and some physicists believe that faster-than-light communication might be possible with some clever manipulation of entangled particles."

So, as far as I am concerned the article by Siegfried was just throwing up a smokescreen because he cannot accept the possibility that the belief in "no instantaneous" is false; that either the understanding of special relativity is false or special relativity is false.

As dealt with my other articles: the way that math is dealt with by relativists using special relativity is a mess, and rather than sort out that mess they instead carry on and make a mess when dealing with such things as quantum entanglement, going so far as to wanting to dismiss "spooky-action-at-a-distance" as a misnomer.

References

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