

Do Quanta Violate the Equation $0 = 0$?

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Dedicated to Marie-Louise Nykamp

Abstract

Ever since the celebrated 1964 paper of John Bell, the statement that "Quantum systems violate the Bell inequalities", [1,2], has a very large support among quantum physicists as well as others claiming some knowledge about quanta. Amusingly, it has so far escaped the general notice that, if indeed, quanta do violate that Bell inequalities, then - due to elementary facts of Logic - they must also violate *all* other valid mathematical relations, thus among them, the equation $0 = 0$. Here the respective elementary facts of Logic are presented.

1. Preliminaries

Usual Quantum Theory, more precisely, the Quantum Mechanics of finite, non-relativistic quantum systems - as all other modern theories of Physics - leads to a system of mathematical equations and other mathematical statements which are supposed to be mathematically correct and logically non-contradictory with one another. Among them are

those regarding the quantum systems which are supposed to violate the Bell inequalities. As is known, [1,2], the respective mathematical statements which are used to claim that quantum systems violate the Bell inequalities can be expressed in a finite number of such statements, thus together, they can be denoted, say, by the mathematical statement s .

On the other hand, and hardly, if at all, known among quantum physicists, the Bell inequalities are of a *purely* mathematical nature, that is, they can be proved based on rather elementary algebra and *without* absolutely any other considerations, be of a physical, philosophical, or other non-mathematical nature, [3-7]. Let us then denote, by b the mathematical statement of the Bell inequalities.

Last, let us denote by z the statement $0 = 0$.

2. The Logical Setup

Now, the mentioned long ongoing and highly popular claim is that

$$(2.1) \quad s \implies non\ b$$

Based on that, we show that the seemingly far stronger implication also hold

$$(2.2) \quad s \implies non\ a$$

where a can be any valid mathematical statement. Thus, we would have in particular that

$$(2.3) \quad s \implies non\ z$$

Now (2.2) amounts to

$$(2.4) \quad (s \implies non\ b) \implies (\forall a \in \mathcal{M} : s \implies (non\ a))$$

where \mathcal{M} denotes a large enough set of valid mathematical statements

in order to include the considerations regarding the present arguments.

Indeed, the proof of (2.4) goes as follows. We recall from Mathematical Logic that

$$(p \implies q) \iff ((non\ p) \vee q)$$

Therefore, (2.4) is logically equivalent with

$$(2.5) \quad (s \wedge b) \vee (\forall a \in \mathcal{M} : ((non\ s) \vee (non\ a)))$$

Let us now assume that (2.5) does not hold. Then we have the valid statement

$$(2.6) \quad ((non\ s) \vee (non\ b)) \wedge (\exists a_0 \in \mathcal{M} : (s \wedge a_0))$$

However, since s is assumed to be valid, it follows that so is $non\ b$, since $((non\ s) \vee (non\ b))$ must be valid. On the other hand, the validity of $(\exists a_0 \in \mathcal{M} : (s \wedge a_0))$ implies that a_0 is also valid.

In conclusion, both $non\ b$ and a_0 are valid.

Now we note that we assumed $b, a_0 \in \mathcal{M}$, hence we obtain

$$b, non\ b \in \mathcal{M}$$

which is a contradiction, since one assumes that Mathematics is contradiction free.

As for the case in which Mathematics may turn out to be contradictory, possible ways to proceed can be found in [8,9] and the literature mentioned there.

3. Strange ... Quantum related phenomena ...

The fact, again hardly, if at all, noted among quantum physicists, is that recently, it was shown in [10] that the Bell inequalities are actu-

ally *not* violated by quantum systems, see also related details in [5-7]. Indeed, as it turns out, the long and widely held opinion that the Bell inequalities would be violated by quantum systems is due to *nothing* else but a rather simple and elementary mistake in the handling of finitely many statistical data.

But let us, for the moment, leave the previous remark aside ...
Then one can still ask the following question :

Why do quantum physicists not keep making noise about
the equation $0 = 0$ being violated by quanta ?

Such a rather ... blunt and eye catching ... question would make not a few things involved sound so much more simple ...

And given such luck, it may also make them much more clear as well ...

Meanwhile, a widespread celebration seems to emerge for what, allegedly, seem to be no less than three major results, [10-12], that are supposed to ... plug once and for all ... the apparent loopholes still existing in various proofs of how the quanta have for long been claimed to ... violate ... the Bell inequalities ...

Well, a somewhat more articulate outside observer may be inclined to quip as follows :

“Science is not done scientifically ...”

But then, why should we be surprised ?
After all, art is seldom, if at all, done artfully ...
Or love, lovingly ...
Let alone, religion religiously ...

However, as if to compensate for all the above less than perfect performances, we can note that ... violence is more often than not done violently ...

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