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Local realism theorem!

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Big Bang

The Cosmic Microwave Background (CMB), „the afterglow“ of the Big Bang, has been found as polarised.

More than 5,500 hours of observations by the Degree Angular Scale Interferometer (Dasi) at the Amundsen-Scott base at the South Pole have made an contribution to the confirmation of the Big Bang theory.

Quantum teleportation

It is claimed that the transfer a quantum state (no transportation of energy or matter) to an arbitrarily distant location across the Danube was successfull (Ursin et al.). The calculations made are based on Bell.

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R. Ursin et.al., *Quantum Teleportation Link across the Danube,* Nature **430**, (2004) 849.

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Causation 8 (2007), 5- 11.

Local realism theorem.

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Abstract

The nature of energy, time and space of the sub-microscopic world, as explained by the non-local interpretation of quantum mechanics must be totally different from the nature of energy, time and space in the macro-physics. In particular, physical processes in the sub-microscopic world occurring at one place appear to have immediate effect on physical processes at another location far away (quantum entanglement). Quantum mechanics is still missing local realism and thus causality. Contrary to all that above, this publication will make the proof, that there is

local realism.

Key words: Einstein–Podolsky–Rosen paradox, Locality, Nonlocality, Realism, Correlation, Causation.

1. Background

Einstein's interpretation of quantum mechanics is to some extent contrary to that of Bohr and Heisenberg. According to Einstein, it is necessary to find a more complete theory of quantum mechanics, one which respects reality and locality. A local, realistic interpretation of quantum mechanics should be compatible with relativity since something strange is going on in quantum mechanics. The mathematical descriptions of the sub-microscopic world today provided by quantum mechanics do not satisfy the locality principle. In other words, it turns out to be, that quantum mechanical objects which are arbitrarily far apart are influenced by each other over such distances, that it is very difficult to reconcile this with relativity theory. Quantum mechanical objects are said to be entangled, when something causes changes on one of two particles, the wave function of the other changes 'simultaneously'.

Specifically, changes which are 'simultaneous' in one frame of reference must not be 'simultaneous' in another frame of reference. So although changes of two events might happen 'simultaneously', there can be a frame of reference which place one first, and an other frame of reference which place the other first. 'Simultaneous' is thus not identical with 'at the same time'.

The mathematics of quantum mechanics entails non-locality thus that a particle somehow determines the state of an other particle, however far away the same is. Einstein concluded therefore in the famous Einstein Podolsky Rosen paper (Einstein et al., 1935) that the quantum theory must be incomplete. According to Bell's theorem we must accept either non-local influences or abandon realism.

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2. Material and Methods

In this publication, we will use the variance of a random variable, the hypothetical syllogism, a rule of inference in prepositional logic and the covariance, to make the proof, that there is local realism.

3. Results

Let us assume that the value of any physical quantity can be predicted with absolute certainty prior to performing a measurement or otherwise disturbing. In so far, let any quantum-level object have a definite and well defined state that determines the values of all other measurable properties. Let distant objects do not exchange information faster than the speed of light. This well defined properties is sometimes called *local realism.*

Theorem 1. Local realism **I.**

Let

X_t	denote something existing independently of human mind and consciousness, f. e. a measurable random variable, a quantum mechanics object etc. at the (space) time t,
$(l)_t + (\text{not } l)_t = X_t$	denote that something that is existing independently of human mind and consciousness, f. e. a measurable random variable, a quantum mechanics object etc. at the (space) time t is determined by local realism and non-local realism (variable), there is no third between local realism and non-local realism, **tertium non datur**,
l_t	denote the local **realism** of something existing independently of human mind and consciousness**,** f. e. of a random variable or of a quantum mechanics object X_t etc. at the (space) time t, the local realistic part of X_t,
$(\text{not } l)_t$	denote the **non-local realism** of something existing independently of human mind and consciousness**,** f. e. of a random variable or of a quantum mechanics object X_t etc. at the (space) time t, the local not-realistic of X_t,
$E(X_t)$	denote the expectation value of something existing independently of human mind and consciousness, f. e. a measurable random variable, a quantum mechanics object etc. at the (space) time t,
$\sigma(X_t)^2$	denote the variance of something existing independently of human mind and consciousness, f. e. a measurable random variable, a quantum mechanics object etc. at the (space) time t,
t	denote the (space) time,

then

$$\sigma(X_t)^2 = E (X_t ^2) - E (X_t) ^2 = 0.$$

Proof by contradiction of the theorem 1.
Let us assume, that the opposite of our theorem above is true. Thus, let us assume **there is no local realism**. Recall, we have defined that

$$l_t + (\text{not } l)_t = X_t. \quad (1)$$

Our assumption is that **there is no local realism**, we set $l_t = 0$. What are the consequences? We obtain the next equation.

$$(\mathbf{l_t = 0}) + (\text{not l})_t = X_t \quad (2)$$

$$\mathbf{0} + (\text{not l})_t = X_t \quad (3)$$

$$\mathbf{(not\ l)_t = X_t} \quad (4)$$

Our assumption according to a proof by contradiction is that there is no local realism. Thus, we obtained an **identity** of $\mathbf{(not\ l)_t}$, the part of $\mathbf{X_t}$ that is non-local and measured and $\mathbf{X_t}$ itself. In other words, the non-local or measured part of $\mathbf{X_t}$ is the whole $\mathbf{X_t}$ itself, there is nothing else, no local realism. We cannot distinguish between $\mathbf{(not\ l)_t}$ and $\mathbf{X_t}$ itself, both are identical and are absolutely the same, $\mathbf{X_t}$ is absolutely non-local. In so far, based on the identity of $(\text{not l})_t = \mathbf{X_t}$ we obtain the next equation.

$$\mathbf{X_t = X_t .} \quad (5)$$

$$X_t * X_t = X_t * X_t . \quad (6)$$

$$X_t^{\,2} = X_t * X_t \quad (7)$$

$$E (X_t^{\,2}) = E (X_t * X_t) \quad (8)$$

$$E (X_t^{\,2}) = E (X_t) * E (X_t) \quad (9)$$

$$E (X_t^{\,2}) = E (X_t)^2 \quad (10)$$

$$E (X_t^{\,2}) - E (X_t)^2 = 0 \quad (11)$$

$$\mathbf{\sigma(X_t)^2 = E (X_t^{\,2}) - E (X_t)^2 = 0.} \quad (12)$$

Q. e. d.

Consequently, if our assumption above is true that X_t is non-local, then the variance of X_t must be equal to zero. In so far, let us perform some precise measurements on X_t and let us find at the same time that the variance $\mathbf{\sigma(X_t)^2 = 0}$ then we have equally found, that X_t is absolutely non-local. Otherwise, every time when $\mathbf{\sigma(X_t)^2 \neq 0}$ we have found equally, that X_t is based on local realism too. According to the proof above, we must accept that there is local realism. The proof above is only a proof, that every thing that exists independently of human mind and consciousness as such is inherently self-contradictory, it is the unity and the struggle between the local realism and non-local realism.

The expression $\mathbf{X_t = X_t}$ is an existing contradiction. How can X_t be equal only to itself and nothing else? If X_t is equal only to itself and nothing else, if X_t is non local, then X_t is **the pure** $\mathbf{X_t}$ and the variance of X_t must be equal to 0 or $\mathbf{\sigma(X_t)^2 = 0}$, no changes. Thus, if X_t is only X_t and thus non-local then there is no becoming, X_t just stays X_t, no changes at all, no movement, all is like it is, there is no development or $\mathbf{\sigma(X_t)^2 = 0}$. It is impossible for X_t to change from non-local realism to local realism, in so far, as X_t changes in this way, it is no longer X_t, it becomes something else. Any changing of X_t implies that X_t does not remain X_t non local but passes into its other, into local realism and vice versa. In other words, if there is no local realism, if it is only true that $\mathbf{X_t = X_t}$**, how can the variance of** $\mathbf{X_t}$ under this condition **be unequal to zero?**

Hypothetical syllogism
In prepositional logic, a hypothetical syllogism expresses a rule of inference of the following form:

$$A \rightarrow B. \quad B \rightarrow C. \quad \text{Therefore, } \mathbf{A \rightarrow C.}$$

Example:

Driving a car (=A) $\rightarrow$ Traffic accident (=B). (13)

Traffic accident (=B) $\rightarrow$ Deadly event (=C). (14)

Therefore,

Driving a car (=A) $\rightarrow$ Deadly event (=C). (15)

Thus, set A as there is no local realism or ($l_t = \mathbf{0}$) . Set B as $X_t = X_t$. Set C as $\sigma(X_t)^2 = 0$.

Theorem 2. Local realism II.

Proof based on hypothetical syllogism.

Premises.

$(l_t = 0) \rightarrow (X_t = X_t)$, which follows from (1),(2),(3),(4),(5). (16)

$(X_t = X_t) \rightarrow (\sigma(X_t)^2 = 0)$, which follows from (5),(6),(7),(8),(9),(10),(11), (12). (17)

Conclusio.

$\mathbf{(l_t = 0) \rightarrow (\sigma(X_t)^2 = 0)}$ (18)

Q. e. d.

This is a very important proof, there is local realism. We assumed that there is no local realism l_t or in other words, $l_t = 0$. In so far, if there is no local realism l_t , then **the variance of X_t must be equal to zero** or $\mathbf{\sigma(X_t)^2 = 0}$. If the existence of $\mathbf{X_t}$ is not based on local realism, then the variance of X_t must be equal to zero or $\mathbf{\sigma(X_t)^2 = 0}$. Consequently, every time when we find $\sigma(X_t)^2 > 0$, we found equally that there is local realism. In so far,

"**The variance ... is a measure of the inner contradictions of a random variable, of changes, of struggle within this random variable itself, or the greater $\sigma(X)^2$ of a random variable, the greater the inner contradictions of this random variable**" (Barukčić 2006a1, p.57).

There is local realism in objective reality. Only, with our proof above, it is not proofed that there isn't any non - local realism. What could this mean?

Theorem 3. The independence of the local realism and non-local realism of something.

X_t	denote something existing independently of human mind and consciousness, e. g. a measurable random variable, a quantum mechanics object etc. at the (space) time t,
$(l)_t + (\text{not } l)_t = X_t$	denote that something that is existing independently of human mind and consciousness, e. g. a measurable random variable, a quantum mechanics object etc. at the (space) time t is determined by a local realistic and non-local realistic part, there is no third between local realism and non-local realism, **tertium non datur**,
l_t	denote the local **realistic part** of something existing independently of human mind and consciousness**,** e. g. of a random variable or of a quantum mechanics object X_t etc. at the (space) time t, the local realistic part of X_t,
$(\text{not } l)_t$	denote the **non-local realistic part** of something existing independently of human mind and consciousness**,** e. g. of a random variable or of a quantum mechanics object X_t etc. at the (space) time t, the non-local realistic part of X_t,
$E(l_t)$	denote the expectation value of the local **realism** of something existing independently of human mind and consciousness**,** e. g. of a random variable or of a quantum mechanics object X_t etc. at the (space) time t, the expectation value of the local realistic part of X_t,
$E(\text{not } l_t)$	denote the expectation value of the **non-**local **realism** of something existing independently of human mind and consciousness**,** f. e. of a random variable or of a quantum mechanics object X_t etc. at the (space) time t, the expectation value of the non-local realistic part of X_t,
$\sigma((\text{not } l)_t , (l_t))$	denote the co-variance of the non-local realistic part and local realistic part of something existing independently of human mind and consciousness, e. g. of measurable random variables, of quantum mechanics objects etc. at the (space) time t,
t	denote the (space) time. Let $(\text{not } l)_t$ be independent from (l_t), let both have no influence on each other, let both not depend on each other,

then

$$\mathbf{\sigma((\text{not } l)_t , (l_t)) = E((\text{not } l)_t , (l_t)) - (E((\text{not } l)_t) * E(l_t)) = 0 .}$$

Proof of the theorem 2.
Let us assume, that there is no relationship between $(\text{not } l)_t$ and its local realistic part l_t . Thus, we have only the pure $(\text{not } l)_t$. We obtain the basic equation.

$$\mathbf{(\text{not } l)_t = (\text{not } l)_t .} \quad (19)$$

$$E((\text{not } l)_t) = E ((\text{not } l)_t) \quad (20)$$

This basic identity is not changed at all by the next operation. We obtain the next equation.

$$E((\text{not } l)_t)*(\quad \mathbf{1} \quad) = E ((\text{not } l)_t) \quad (21)$$

Our assumption is that there is a local realistic part (l_t) inside something that is different from 0. Only, this local realistic part (l_t) inside something has nothing to do with the local non-realistic part $(\text{not } l)_t$ of the same something X_t. In so far, let $\mathbf{E(l_t) \neq 0.}$ Equally it is true that $\mathbf{E(l_t) / E(l_t) = 1}$. Thus, we obtain the next equation.

$$E((\text{not } l)_t)*(E(l_t) / E(l_t)) = E ((\text{not } l)_t) \quad (22)$$

$$E((\text{not } l)_t)* E(l_t) = E ((\text{not } l)_t) * E(l_t) \quad (23)$$

$$E((\text{not } l)_t , (l_t)) = E ((\text{not } l)_t) * E(l_t) \quad (24)$$

$$E((\text{not } l)_t , (l_t)) - (E ((\text{not } l)_t) * E(l_t)) = 0 \quad (25)$$

$$\mathbf{\sigma((not\ l)_t , (l_t)) = E((not\ l)_t , (l_t)) - (E((not\ l)_t)*E(l_t)) = 0 .} \quad (26)$$

Q. e. d.

If something that is existing independently of human mind and consciousness possesses a local realistic part l_t that is absolutely independent from the non-local realistic part $(\text{not } l)_t$ of the same something, then it must hold true, that

$$\mathbf{\sigma((not\ l)_t , (l_t)) = 0,}$$

otherwise, once again we are in trouble. On the other hand, if

$$\mathbf{\sigma((not\ l)_t ,(l_t)) \neq 0}$$

then it is proofed, that the local realistic part l_t of something existing independently of human mind and consciousness and the non-local realistic part non-l_t of the same of something existing independently of human mind and consciousness are somehow depending on each other, are related to one an other, the one cannot without its other and vice versa. This dependency must not be a causal one.

The following 2x2 table gives an overview between local and non-local realism.

		Realism		
		yes	no	
Lo-cal-ity	yes			
	no			

4. Discussion

This paper was able to confirm the existence of local realism. A local, realistic interpretation of quantum mechanics which respects reality and locality and thus causaliy is possible. Such a local, realistic interpretation of quantum mechanics will be compatible with relativity theory and is possible and necessary.

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The logic of Bell test experiments.

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Abstract

Is our world locally realistic? More and more Bell test experiments were performed to determine whether this is correct or not. Nonetheless, is there something like a logical structure behind such nonlocality experiments/proofs? The purpose of this publication is to make the proof that

Bell test experiments are based on a dilemma.

Key words: Bell's theorem, Logical fallacy, Refutation, Fallacy of the excluded middle

1. Background

Per Bell's theorem, either quantum mechanics is wrong or local realism is wrong, a third is not possible. Meanwhile, Bell test experiments were performed to determine which is correct. There is indeed no way out, the inequalities of Bell's theorem are violated. The results of an experiment performed by Aspect are more or less interpreted as a confirmation of the discrepancy between local realistic theories and quantum mechanics and the impossibility of local hidden causality. Quantum mechanics is thus considered as a non-local theory. Bell's theorem is offering us only two possibilities, of which neither is acceptable. Either local realism is wrong or quantum mechanics is wrong. The following 2x2 table gives an overview of the relationship between local realism and quantum mechanics based on Bell's theorem.

Per Bell's theorem		Quantum mechanics		
		true	wrong	
Local realism	true		1	
	wrong	1		
				1

Bell's theorem is already refuted (Barukčić, 2006d). Besides of this, the same was taken and I am sure will still be taken to show how experimentally to falsify local realism. A falsification of local realism would provide support for nonlocality - one feature of a special interpretation of quantum theory.

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2. Material and Methods

According to d'Espagnat we should keep in mind that the "doctrine that the world is made up of **objects** whose existence is independent of **human consciousness** turns out to be in conflict with **quantum mechanics**." (d'Espagnat 1979, p. 128). In this paper, we direct our attention to the structure of nonlocality proofs. Most of the nonlocality proofs are based on the assumption, that "either the local realistic theories or quantum mechanics must be wrong" (d'Espagnat 1979, p. 128). The conceptual error in the design and structure of nonlocality proofs is demonstrated by simple classical logic for clarity. It is not possible to lean on the design of nonlocality proofs to decide whether our world is locally realistic or not.

3. Results

A great deal of this work is to discover the logic of nonlocality proofs. The logic of nonlocality proofs can be described in terms of a disjunctive syllogism:

Either p or q.
Not p.
Therefore, q.

Example. Either 1 + 0 = 1 must be wrong or 0 + 1 = 1 must be wrong. A nonlocality experiment is performed. It is found that 0 + 1 = 1 is true. Thus we must conclude, that 1 + 0 = 1 must be wrong.

Theorem. The logical fallacy of the excluded middle - dilemma I.

Premise.
Either 1 + 0 = 1 must be wrong or 0 + 1 = 1 must be wrong.

Proof.
Nonlocality experiments are performed. Perfect correlation's are obtained.
The result of this experiment is: it is not true that 0 + 1 = 1 must be wrong.

Conclusion.
It is true that 1 + 0 = 1 must be wrong.
Q. e. d.

Based on the construction error of nonlocality experiments, we are forced to accept a conclusion which is obviously fallacious, we have no other choice. We must accept either the one or the other. There is no escape out of this. The following 2x2 table gives an overview of this experiment.

Per Bell's theorem		0 + 1 = 1		
		true	wrong	
1 +0 = 1	true		1	
	wrong	1		
				1

The logic of nonlocality proofs is based on a Black-Or-White Fallacy, an Either-Or-Fallacy or a dilemma. The disjunctive premise of the nonlocality proofs is false. The two alternatives as presented by the premise of the nonlocality proofs are held to be the only options possible while in reality there exist a lot of other options which have not been considered by the premise of the nonlocality proofs. Further, the two alternative points of view are equally often two extreme points.

In reality, there are many other reasons why relations are the way they are which have not been considered by the nonlocality proofs. It is very difficult to recognise a dilemma but even more difficult to escape the same. A dilemma is based on a misuse of the *or* operator too. Only if it were somehow proven that in reality there were no other possibilities than those presented in the initial dichotomy, then the logic the nonlocality proofs could be expected to be sound. But until then, nonlocality proofs are fallacious. A false dilemma limited to 3 choices is called trilemma and so on.

Example. The smile of Alice - A logical fallacy of the excluded middle - dilemma II.

Alice is smiling.

Premise.
Either Alice must be in love with Bob or Alice was awarded the Nobel prize for physics.

Proof.

Nonlocality experiments are performed. Perfect correlation's are obtained.
After an investigation it is found for sure, that
Alice was not awarded the Nobel prize for physics.
Thus, we are forced to accept the following conclusion.

Conclusion.
Alice must be in love with Bob.
Q. e. d.

There are thousands of other reasons, while Alice is smiling. One of this reasons can be that Alice is in love with Bob. But this must not be the only one reason. What if Bob has decided to use an apartment next door to Alice? What if Alice is pregnant? What if ... The nonlocality experiments/proofs are constructed that way, that we must accept the other, if the one is refuted, it doesn't matter at all, whether the same is true or not. Experiments that are designed that way are more or less useless. This experiments are useless too, because correlation analysis is used to analyse the relationship between random variables. On the other hand, conclusions are made about causation. Correlation has nothing to do with causation and vice versa (Barukčić 2006a1, p. 314, pp. 341-343). It is not allowed to make conclusions about causation that are based on correlation. Nonetheless, this is repeatedly done.

d'Espagnat is drawing the logical structure of the nonlocality proofs very precisely. He writes that

"either the local realistic theories or quantum mechanics must be wrong" (d'Espagnat 1979, p. 128).

This is what the most nonlocality proofs are about and nothing more.

The nonlocality proofs are more or less useless.

Theorem. The logical fallacy of the excluded middle - dilemma III.

Premise.

Either local realistic theories must be wrong

or quantum mechanics must be wrong.

Proof.
Nonlocality experiments are performed. Perfect correlation's are obtained.
The result of such experiment is more or less:
it is not true that quantum mechanics is wrong.
In so far, we are forced to accept the following conclusion.

Conclusion.
Local realistic theories must be wrong.
Q. e. d.

The basic relationship between locality and quantum mechanics is reduced to either the one or the other. But are this really the only possible alternatives in reality? What, if it is true that without local realism no quantum mechanics?

		Quantum mechanics		
		true	wrong	
Local realism	true	1	1	
	wrong	0	1	
				1

What, if it is true that when local realism then quantum mechanics?

		Quantum mechanics		
		true	wrong	
Local realism	true	1	0	
	wrong	1	1	
				1

And so on ...

There are some possibilities to response to a dilemma. We can choose one of the choices as true and try to refute the other. Let us accept quantum mechanics as correct. Since it is proofed, that local hidden variable exist (Barukčić, 2006c), Bell's theorem is refuted from this point of view too. Alternatively it is possible to refute both too by showing that in reality there exist other options too which have not been considered to a necessary extent. I am not sure, whether it make sense to refute quantum mechanics.

The detectors of photons seems not to interact with the photons at all, the photon pairs pass through the polarisation analysers without any interaction or disturbance, no reflection, nothing. In absence of any experimental confirmation, it is assumed that all photons or electrons emitted by a source are observable, and that the detection rates of photons ("detection loophole") or electrons are perfect. There is no other influences on the system, neither from outside nor from inside.

It is commonly agreed that there is still very little agreement among philosophers and among physicists, that such an perfect detector exists.

4. Discussion

The question of the compatibility of the special theory of relativity with quantum mechanics is not difficult to resolve. Both theories deal about the relationship between energy, time and space. It is not reasonable to accept, that energy, time and space of the micro cosmos has totally other properties then energy, time and space of the macro cosmos.

In so far, as demonstrated above, nonlocality proofs are constructed upon a fallacy. Nonlocality proofs are based upon the fallacy of the excluded middle, commonly referred to as a false dilemma. An extreme simplification of relationships between random variables is the foundation of nonlocality proofs. The design and structure of nonlocality proofs is not sound. The most of them are absolutely useless.

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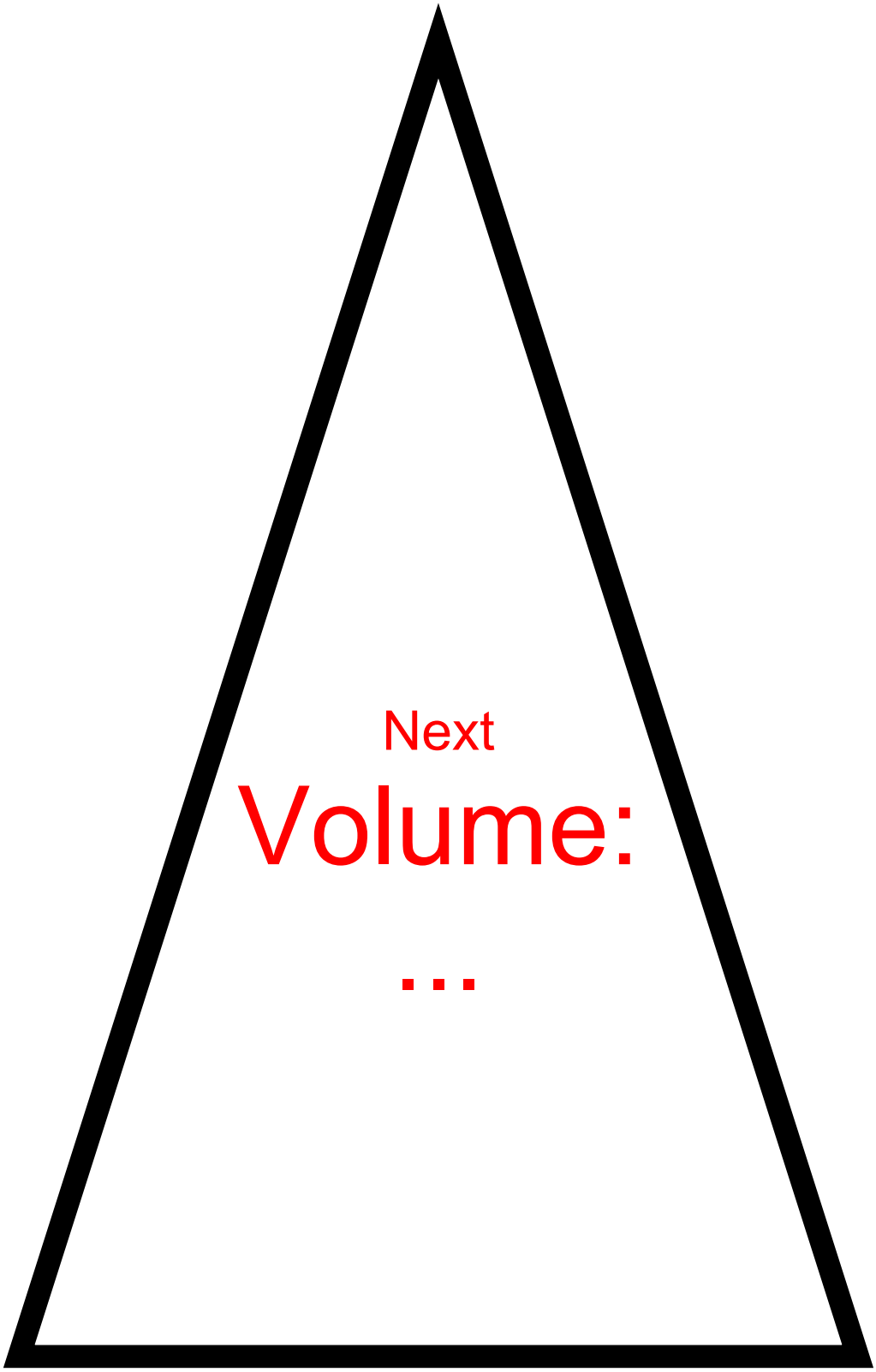

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