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Why Does the Number 58 Unite Electrical and Gravitational Forces?

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Abstract

Many theoretical and experimental findings in physics and other areas of the natural sciences may incorrectly assume that a global measurement, such as the measurement of the acceleration of a particle, will be linearly represented by a corresponding reading on a measuring device, because the specific configuration of the measurement itself influences the reading. In particular *point measurements*, which are measurements taken in one physical location, may cause asymmetries that need to be corrected in order to achieve the desired outcomes. These asymmetries become more dominant at relatively high velocities and with relatively light particles.

The proposed theoretical model offers an explanation of the relationship between electrical and gravitational force by deconstructing the way that the measurement of acceleration is conducted and, with a high level of accuracy, offers a description of a relationship between electrical force and gravitation.

This letter aims to contribute to critical reflection on the assumptions behind measurement and interactions. This may not only further the field of metrology, but also provide a basis for a better understanding of the relationship between global phenomena in certain observed reality and their local influence at a certain point of observation.

1 Introduction

Measurements in physics and technology often assume a linearity between the global phenomena under investigation and the local interactions that convey the information to the measuring device. In a previous article, on which this contribution builds [1], it was demonstrated that this assumption can be questioned in the case of *point measurements*; measurements that are conducted from one physical location. For instance, the measurement of velocity of an object under investigation, or *presence* p [2], requires at least two consecutive samples[3] that are not necessarily taken from two symmetrical locations with respect to the location O of the measuring device, because the angles and distances with respect to O can be mutually different. The basic model is depicted in figure 1. If, for example, one aims to measure the speed of a planetary object, then this may be performed by a telescope that captures the light that is emitted or reflected against the object. The photons therefore carry information about the presence, which is *interpreted* to yield the required outcomes. It can be proven that the geometrical differences between consecutive measurements result in non-linearities, or *myopia*, in the measurements, that need to be corrected in order to achieve the desired results.[1]

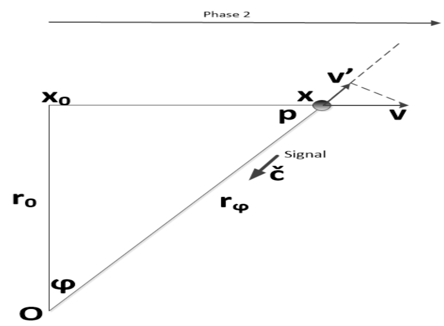

Figure 1: Presence traveling with velocity v with respect to O

One important outcome of the previous article that is relevant for the discussion here, is that the velocity of the presence is *superimposed* on the velocity $\breve{c}$ of the signals. The timing of the signals in O therefore changes with the velocity of the presence, and this affects the measurement. For one, this results in changes of the time *between* signals and therefore the intervals Δs. The article demonstrated that if information about these locations are conveyed to O through signals with finite speed $\breve{c}$ and the velocity of the presence with respect to O affects $\breve{c}$, that the measurement will cause an asymmetry. This will affect the quality of the measurement if the velocity v of the presence increases to $\breve{c}$. If the planetary object in our example therefore moves with a velocity close to the speed of the photons that the telescope detects, then the measurement becomes distorted, and the collected data needs to be corrected for the observed effects. It was demonstrated that the results are in accordance with general accepted theories about the motion of particles with high velocity.[4] An extremely important result of this research was that if $v \approx \breve{c}$, that the nature of the measurement changes, as consecutive measurements are no longer possible. If $v < \breve{c}$ then v and its derivatives such as impulse p and kinetic energy E can be measured, because consecutive measurements are possible.[5] If $v \approx \breve{c}$ then only the existence of the presence can be measured, for instance its extensity e (e.g. mass or charge).[6] This will typically occur at the smallest distance between the presence and O, because the superposition of v is zero at that point. As a result, the presence will still have an effect in O, but not as clearly as when v is relatively small.

This follow-up article asks the question how the acceleration of a presence is transferred to O in the model of measurement that is developed here, and is depicted in figure 1. It stands to reason that if the velocity of a presence is superimposed on the speed $\breve{c}$ of a signal, that this must also apply for the acceleration a, and with it the measured force F and other physical attributes that are derived from measuring the acceleration. But, just like the superposition of velocity, the transformation of the acceleration of a presence into local interactions in O is not straightforward. We will therefore begin by developing a hypothesis of how this transformation occurs, and then test this hypothesis with well-established outcomes of Newtonian mechanics.[7, 8]

2 Cannery Row

Suppose you are in a factory that produces canned fish.[9] As the cans are travelling along the transport belts towards the packaging departments, a sensor picks up the cans as they are moving along. The sensor is performing a single measurement, and the cans are presented to that sensor as recurring signals of zero (or 'low') values in the spaces between two cans, and 'one' (or high) when a can is registered. For the sensor, the cans are therefore represented in time as patterns,[10, 11] or waveforms. The special characteristics of the cans (e.g. weight, magnetic properties, or reflecting light, are only picked up if the measurement allows it. In the consequent waveform of the reading these characteristics are all generalised to an *extensity* e,[6] which signifies the top and the through of the waveform that is detected. If one wants to get an indication of the speed of the cans that are moving past the sensor, one can either measure the time between cans that are moving past the sensor, or use a fixed time and count the cans within that time frame. Suppose now that the production the cans is accelerating, then both measurements will show a gradual increase of cans, or shorter time intervals, until the belt is so filled up that the sensor is no longer able to detect individual cans. This means that *at some point* the measurement will fail, and this moment is proportional to the acceleration. According to the central limit theorem (CLT)[12] the distribution of the *sample average* X_n will then approach a normal distribution if the amount of samples n (or cans) approaches infinity, for instance with a Gaussian function:[13]

$$a \equiv \frac{1}{\sqrt{2\pi\sigma^2}} e^{\frac{-(x-\mu)^2}{2\sigma^2}} \tag{1}$$

This can literally occur in many production halls when normal operation is disturbed, and products start piling up. In the case of cannery row, n has a relationship with a:

$$n \equiv k_1 e a \tag{2}$$

In the above equation, e stands for the amount of cans at a given unit of time, and k_1 is a certain constant. If the acceleration is relatively low, then it takes a long time for n to increase. Conversely, if the acceleration is high, then it doesn't take long before the measurements take the form of a random walk.[13] But with accelerating production this will eventually always happen. The distribution of consecutive measurements thus bears a direct relationship with the increasing velocity of the cans:[14]

$$\lim_{n\to\infty} \frac{E(S_n)}{\sqrt{n}} \equiv \sqrt{\frac{1}{k_1 a}} \lim_{e\to\infty} \frac{E(|S_e|)}{\sqrt{e}} = \sqrt{\frac{2}{\pi}} \tag{3}$$

Or:

$$a \equiv \frac{\pi}{2} \tag{4}$$

If the cans now resemble signals that can or cannot interact with the measuring device in O, then the previous article already puts an upper bound to this type of measurement, namely when the velocity of the presence is equal to the speed $\check{c}$ of the signals.[1] It can also be assumed that the direction of the acceleration is not really important, as the compacting of signals will always occur, owing to their wave-like manifestation in O. But as signals already have a velocity $\check{c}$, and the acceleration of the presence is superimposed on this, it is likely that the probabilistic effects take place much sooner, and the speed v of the presence is not really a determining factor in this equation. In terms of cannery row, the belt may run a bit faster or slower, but the distribution of cans will still have the same general form.

So we can formulate a hypothesis that the acceleration is associated with the distribution of consecutive (correct) measurements of signals, for instance with a Gaussian function.[15] For relatively low acceleration with a high density of signals, the distribution will more closely resemble a spike, while the distribution will be relatively flat and rounded when the acceleration is high or signals are sparse. In the latter case the distribution will approximate the outcome of (4). The interesting question is whether this hypothesis can be verified in a physical reality.

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3 Signals and Information

Suppose that a particle is travelling with velocity v in a perpendicular direction to O, where a measurement device is located, as is depicted in figure 1. A number of consecutive measurements of the signals between location x and x_ϕ may reveal that a certain force is influencing the presence, and that this force, by convention, is F=ea, where e stands for a certain extensity.[6] If for instance, the extensity is the mass m of the presence, then Newtonian mechanics suggests that $F = ma$ *[N]*.[7] However, this information is not directly transferred to O, but instead is relayed to O by certain *signals.*The measurement device *interprets* the signals in close vicinity of the measuring device. If these local interactions are also based on a force F_O and that this force is based on a certain quality q of a signal and a certain scaling factor E, so that:

$$F = ma = kF_O = kqE \tag{5}$$

As signals are discrete, the factor $k \in \mathbb{N}$ determines how the remote force is transformed in an equivalent local force that can directly interact with the measuring device, and which will eventually yield a reading. As a result, the signals relay information about F that is interpreted to yield the above result of ma:

$$a = \frac{kqE}{m} \tag{6}$$

In a situation where signals are sparse, then it stands to reason to use the lightest mass known to physics. If the particle is an electron with mass m_e and that the force F_O in O is the result of electrostatic attraction, so that $E = \epsilon\Xi$, with $\epsilon = \frac{1}{\mu_0 c^2}$ and Ξ being a certain scaling factor, then this will yield: [8]

$$a = \frac{q\epsilon}{m}k\Xi = \frac{q}{m\mu_0 c^2}k\Xi[ms^{-2}] \tag{7}$$

Filling in the following well-known physical constants in the equation:

1. electric mass $m_e = 9.109383713982.10^{-31}[kg]$
2. magnetic permittivity $\mu_0 = 4\pi.10^{-7}[kgms^{-2}A^{-2}]$ [1][1]
3. light speed $c = 299792458[ms^{-2}]$
4. elementary charge $q_e = 1.602176634.10^{-19}[C]$

$$a = \frac{q_e}{m_e\mu_0 c^2}k\Xi \rightarrow a = 0,49570152495\pi k\Xi \rightarrow a \approx \frac{1}{2}\pi k\Xi[ms^{-2}] \tag{8}$$

If $k\Xi = 1$, then (8) suggests that the acceleration of an elementary mass will always represented as a constant value that is approximately $\pi/2$, which seems to confirm the hypothesis that presented in cannery row. This obviously does not prove the hypothesis, but does demonstrate that the model that is developed here based on local interactions of signals has outcomes that are in league with physical reality. Also, this outcome is *purely* the result of scaling well-known factors of physics in a certain fashion, and the interpretation developed here only offers an argument as to *why* this relationship between these factors exists!

[1] The approximation of $\mu_0 = 4\pi.10^{-7}$ is used here because the difference with the actual value is marginal for this discussion, and the approximation is more valuable to further the argumentation

As was expected, this particular outcome of the acceleration presents itself when dealing with the smallest mass that can be measured, and apparently the distribution of signals then follows the pattern[10] of a random walk.[14]

If the mass increases, then a becomes smaller, so (8) can be rewritten in a more general form. Assuming that the mass of the particle m is always a discrete multiple of the electric mass $m = \eta m_e$, with $n \in \mathbb{N}$, then:

$$a = \frac{\pi}{2\eta} \tag{9}$$

In other words, *k=1* and $|\Xi| = 1[J^2C^{-3}]$ is only needed to derive the correct dimensions.[2]

There are some interesting features in the particular grouping of (8). It was argued in the previous article that Einstein's famous equation $E = m\breve{c}^2$ does *not* represent the maximum energy that is 'contained' by a particle with mass m,[4] rather it should be seen as the maximum (kinetic) energy that can be *measured* in O, when the velocity of the signals is $\breve{c}$.[1] The more generalised form is $\frac{q}{e\breve{c}^2}$ where q and $\breve{c}$ are properties of the signal, and e is the extensity of the presence that is passed through the signals and measured in O.

Therefore, the relationship:

$$s_e = \frac{q}{m_e\breve{c}^2} = \frac{q}{E_e}[CJ^{-1}] \tag{10}$$

can be considered as a discrete unit of information about the mass of a presence that can be transferred to O by a signal with a charge q and travelling with velocity $\breve{c}$. As with light speed, the factor $\breve{c}^2$ is provided by the vacuum permittivity μ_0, and so this means that this constant can also be 'deconstructed' to a greater extent:

$$\mu_0 \approx \frac{2}{\pi}\frac{q_e}{m_e c^2}\Xi = \frac{2}{\pi}\Xi s_e[kgmC^{-2}] \tag{11}$$

Apparently, with an extremely small margin of error, The factor μ_0 can be discounted in the physical constants q, m_e, and c! This factor then can be interpreted as the minimal unit of information about the mass in O. The equation also suggests that these constants give an insight in the qualities of the signals that relay global information about the presence to local interactions in O. For instance, it has already become clear that the signals carry electrical charge, so that $q = q_e$!

The fact that the acceleration is tied to a probabilistic property, as is suggested in the hypothesis formulated in (3) and (4), offers support for the argument that this is an effect of the configuration of the measurement, and is not an intrinsic quality of the constants themselves. The above equations also suggest that, rather than the magnetic permittivity, the factor $a_e\mu_0 = 2\pi^2 10^{-7}$ is the defining physical constant that links the global measurement of force to interpretable information in O:

$$a_e\mu_0 = s_e = \frac{q}{m_e\breve{c}^2}[Ckg^{-1}m^{-2}s^2] \tag{12}$$

At this point, the hypothesis that was presented in cannery row gets some support by the specific values of physical constants and the probabilistic nature of the measurement of acceleration. It is also evident that in this model the *global, analogous* measurement of the acceleration of a presence is locally presented in O by *discrete* values, because the signals are fundamentally discrete units in the model.

[2]The rest of this article will not pay a lot of attention to scaling the equations to the correct dimensions, unless it is necessary to further the argument. This is done for reasons of clarity of argument.

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4 Gravity

Suppose now that two mass-bearing presences, or particles, are attracting each other according to:

$$F = ma = \gamma \frac{mm'}{r^2} \to a = 4\pi\gamma \frac{\eta m_e}{4\pi r^2} \tag{13}$$

With γ being the gravitational constant $\gamma = 6.6743015.10^{-11}[kg^{-1}m^{-1}s^2]$.[7] The Newtonian equation that is normally used has been extended with the factor 4π in order to compensate for the spatial aspects of the measurement as, just like electrical charge, the signals will distribute themselves over the surface of a circle between the presence and O, with a radius of r. If these spatial properties are ignored and the equation is normalised in order to remove the influence of the second mass *($m_e = 1$)* then, according to (9):

$$a = \frac{2}{\eta\pi} \equiv 4\pi\gamma \to \eta = \frac{1}{2\pi^2\gamma} = 759039606.2 \tag{14}$$

But because η should be a discrete value, the following assumption can be made:

$$\gamma = \frac{1}{2\pi^2\eta} = \frac{1}{2\pi^2 759039606} = 6.674301502.10^{-11} \tag{15}$$

In other words, if this line of reasoning holds, then the gravitational constant has been made more precise with two digits!

Returning to the original premise of the model that is developed here, the underlying hypothesis states that the probability of detecting signals becomes increasingly small as the presence accelerates. Suppose now that measured signals always get 'trapped' by the measuring device in order to be processed, then this means that there have to be signals floating around that have not been trapped (yet). It was observed in (8) that there is a slight error in the calculations that has been largely ignored so far. It is therefore worthwhile to take a closer look at this error ψ between the ideal value of μ_0 and the calculated value μ_{0m} based on the known constants in physics.[3]

If this is incorporated in (11) then:

$$\psi = \frac{\mu_{0m}}{\mu_0} = \frac{1}{4\pi 10^{-7}} \Xi \frac{2}{\pi} \frac{q}{m_e \check{c}^2} = \frac{1}{2\pi^2 10^{-7}} \frac{q}{m_e \check{c}^2} \Xi \tag{16}$$

Assuming that the physical constants are known with a high accuracy, this can only mean that this error is somehow related to $\check{c}$, which apparently is slightly lower than the speed of light:

$$\frac{\psi \check{c}^2}{\Xi} = \frac{1}{2\pi^2 10^{-7}} \frac{q}{m_e} \tag{17}$$

Note here that the left-hand side of the equation now has a certain dimension, provided by Ξ, with $|\Xi| = 1$. Assuming that these dimensions are 'part' of ψ, then (17) can also be written as follows:

$$\psi = (1-\xi)^2 \to (1-\xi)^2 \check{c}^2 = \frac{1}{2\pi^2 10^{-7}} \frac{q}{m_e} \tag{18}$$

This notation takes the square of $\check{c}$ in (16) into account and puts a focus on the difference between μ_0 and μ_{0m}. Incorporating this in (11) yields:

[3] The author is aware that the ideal value of μ_0 is not exactly $4\pi 10^{-7}[Hm^{-1}]$, but the difference too small to have a significant effect on the calculations and the argument that is developed here

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$$\mu_0 = \frac{\pi}{2}\frac{q}{(1-\xi)^2 m_e c^2} \tag{19}$$

With:

$$\breve{c} = c\sqrt{1-\xi} \tag{20}$$

According to (8):

$$\psi = 0,49570152495/0.5 = 0.9914030499 \tag{21}$$

And so:

$$\xi = 1 - \sqrt{\psi} = 4.30775342.10^{-3} \tag{22}$$

Interestingly enough, the following relationship *also* applies:

$$\frac{q}{m_e \xi} = \eta \approx \frac{1}{2\pi^2\gamma} \rightarrow \xi \approx \frac{m_e}{2\pi^2 q\gamma} = 4.315618428.10^{-3}[kg^2C^{-1}ms^2] \tag{23}$$

In other words, the gravitational constant can be associated with electric charge and electric mass, if ψ is included in the equation:

$$\gamma \approx \frac{m_e}{2\pi^2 q\xi} \tag{24}$$

But now ψ carries a certain dimension as is depicted in (23). This factor can be interpreted as a measure for the amount of signals that are not detected in O. ψ provides the dimensions to make this transformation possible. Following this line of reasoning this means that gravitation is simply the effect of free roaming signals!

The only problem is that there are now two outcomes of ψ, formulated in equations (22) and (23), which are almost, but not exactly the same. As ψ is related to the speed $\breve{c}$ of the signals, this difference can be interpreted as the bandwidth within which $\breve{c}$ operates, and which allows superposition of acceleration a of the presence onto $\breve{c}$:

$$\begin{aligned} &298166442.1 <= \breve{c} <= 298501026[ms^{-1}] \rightarrow \\ &\breve{c} = 298333734 \pm 167292[ms^{-1}] \end{aligned} \tag{25}$$

The upper bound is associated with a relatively sparse distribution of signals (light masses), where the probability of missing signals takes somewhat longer than when the distribution is more dense. But this bandwidth is still quite small with respect to $\breve{c}$ itself.

There is, however, another possible refinement to the model and the consequent interpretation of ψ if one considers:

$$\alpha = \frac{1}{\xi} \tag{26}$$

With this, a new bandwidth can be defined:

$$\begin{aligned}
\alpha_1 &= \frac{1}{4.30775342.10^{-3}} = 232.1395638 \\
\alpha_2 &= \frac{1}{4.315618428.10^{-3}} = 231.7165006 \rightarrow \\
\alpha_{avg} &= 231.9280322 \rightarrow \alpha \approx 232
\end{aligned} \tag{27}$$

As α can be divided by *4*, with $n = 232/4 = 58$, equation (19) can also be formulated as follows:

$$\mu_0 = \frac{2}{\pi}\frac{4n^2}{(4n^2-1)}\frac{q}{m_e c^2} \tag{28}$$

But the factor $\frac{\pi}{2}$ can also be considered as the Wallis product:[16, 17]

$$\frac{\pi}{2} = \prod_{i=1}^{\infty}\frac{4i^2}{(4i^2-1)} \tag{29}$$

Therefore:

$$s_e = \mu_0 a_e = \mu_0 \prod_{i=1}^{\infty}\frac{4i^2}{(4i^2-1)} = \frac{4n^2}{(4n^2-1)}\frac{q}{m_e c^2} \tag{30}$$

For $n = 58$ we can interpret this as the amount of signals that 'leak' from the interaction in O! If $\frac{\pi}{2}$ stands for a complete transfer of signals, then there will be a specific amount that is lost when the particle is accelerating and which contributes to gravitational force. There will therefore always be a value of n that most closely captures this. The bandwidth spanned by ψ thus is simply the margin $< n-1, n+1 >$ in the Wallis product.

In the model presented here, the Wallis product therefore describes the pattern [11, 18] on how a_e is represented in O as a flow of signals with a certain probability of being detected by the measuring device, and the excluded part of the product signifies the 'leak' of signals that contributes to gravitational force. This interpretation gives even more reason to consider ψ as a fundamental property of the measurement of a, instead of an 'error'. Thus ψ indeed carries a dimension that allows for the subsequent transformation from the electrical domain to gravity.

5 Discussion

This theoretical exercise aims to draw attention to the complexities of a seemingly straightforward measurement, in this particular case the measurement of the acceleration of a presence in motion. It suggests that the assumption of symmetrical measurements, where a quality that is measured returns in a reading (or response) in a linear fashion, is worth critical reflection. Most notably, this issue was demonstrated by configuring well-known physical constants in such a fashion that it yields the geometrical property of $\frac{\pi}{2}$ which is known to also return in many probabilistic forms. It was then argued that this property emerges as a consequence of the specific way that the measurement is carried out. The well-known constants that are commonly used in physics are in fact combinations of the intrinsic qualities of the presence under investigation and the characteristics of way that these qualities are measured. Most notably with *point measurements*, where the desired qualities of that presence are relayed to the origin through certain signals with finite speed to a single point of origin.

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Although the article speaks of 'measurement' and 'measuring device' in O, the consequences of this stance are much more fundamental than simply a discussion of metrology.[19] It can be argued that point measurements are the most common way in which particles 'sense' other particles and respond accordingly. This means that the characteristics of such point measurements affect the entire field in which that particle operates and in the response characteristics of all other particles in its sphere of influence. The characteristics of the measurement thus become to be seen as 'part' of the particle itself, or of the field that is spanned around that particle. A deconstruction of these point measurements can therefore contribute to a more fine-grained understanding of the relationship between the characteristics of a particle and how it affects other particles within its sphere of influence. It can even be posited that gravitational force is the result of mutually accelerating particles, because of probabilistic 'leaking'!

In this contribution, the model focuses on the effects that an accelerating particle has on a given location in our universe and how the information of a global, analogous measurement is transferred to local, discrete interactions in that location. Most notably, the model can, with a high level of accuracy describe:

1. the magnetic permittivity μ_0 in terms of electrical charge q, electrical mass m_e, and the speed of light c
2. a relationship between electrical force and gravitation, which is seen as the result of signals that have not (yet) interacted with particles, defined by the factor ξ
3. the gravitational constant γ in terms of electrical charge q, electrical mass m_e, and ξ
4. a more accurate value for the gravitational constant γ
5. the acceleration a of a presence as a pattern described by the Wallis product
6. Gravitation as the result of mutually accelerating particles

Although the proposed model does have a slight margin of error, this can be explained within the logic of the model, and one of these seeming errors actually *provides* the relationship between electrical and gravitational force. The other error can be explained as a bandwidth in which the acceleration actually can manifest itself locally.

Entering the realm of speculation, there is an interesting open question about the sign of the signals. It was demonstrated earlier that in the model a signal carries electrical charge, but it did not mention whether this is positive or negative. It could be hypothesised that, since a neutral mass in practice consists of a balance of positive and negative particles, that signals can carry either charge. Due to gradual dispersion, opposing signals will not easily combine but it could be possible that a combined signals exists, maybe with the characteristics of dipole. In whatever capacity, the combined signals will span a field that is globally neutral, and therefore very hard to detect. If signals can carry either charge, the 'leak' per sign is $\frac{58}{2} = 29$. As this is a prime number, it could be argued that this is the true elementary number of the model that has been developed in this article. Following the logic of the model it would also seem that the nature of signals may depend on the relative speed to O:

1. $v < \breve{c}$: electrical charge
2. $v \approx \breve{c}$: signal

3. $v >= \breve{c}$: 'ghost' particle

Regardless, the nature of signals remain largely speculative without solid experimental evidence.

And, tongue in cheek, this contribution also seems to falsify [20, 21] the claim proposed in Douglas Adams' famous book "the Hitchhiker's Guide to the Galaxy" [22] as, instead of the number *42*, rather number *58* provides the answer to all the grand questions of the Universe!

Obviously, and pun aside, the pretenses of this contribution are modest, as it simply aims to demonstrate the risk of assuming linearity and symmetry in certain measurements that may affect the way that we understand our perceived reality. This may give support in developing more accurate and fine-grained theories of that reality.

6 Data availability

No data sets have been used for this article and all information provided is based on generally available sources

7 Conflict of interest

The authors declares that there is no conflict of interest.

8 Copyright Notice

References

[1] Cornelis Pieter Pieters. "Asymmetry in Measurements near Light Speed". In: *London Journal of Physics* 1.2 (Oct. 2024). DOI: DOI:https://doi.org/10.69710/ljp.v1i2.10887. URL: https://www.researchgate.net/publication/380027557_Asymmetry_in_Measurements_near_Light_Speed.

[2] Terrence W. Deacon. *Incomplete Nature*. English. Unabridged edition. New York: W. H. Norton & Company, 2013. ISBN: 978-1-5226-5668-5.

[3] David Lindley. *Uncertainty: Einstein, Heisenberg, Bohr, and the Struggle for the Soul of Science*. Anchor, Feb. 2008. ISBN: 1-4000-7996-9.

[4] Albert Einstein. *Mijn Theorie; over de speciale en de algemene relativiteitstheorie*. Nederlands. Het spectrum, 1997. ISBN: 978-90-274-5758-5.

[5] David M. Wittman. "Energy and Momentum". In: *The Elements of Relativity*. Ed. by David M. Wittman. Oxford University Press, June 2018. ISBN: 978-0-19-965863-3. DOI: 10.1093/oso/9780199658633.003.0012. URL: https://doi.org/10.1093/oso/9780199658633.003.0012 (visited on 04/09/2024).

[6] P.C. Breedveld and J.J. van Dixhoorn. *Technische Systeemleer*. 1989.

[7] Marcelo Alonso and Edward J. Finn. *Fundamental university physics Volume 1: Mechanics*. English. Addison Wesley.

[8] Marcelo; Finn Edward J. Alonso. *Fundamental University Physics: Volume II, Fields and Waves*. English. Addison-Wesley Publishing Company, Inc.

[9] John Steinbeck. *Cannery Row: John Steinbeck*. English. London: Penguin Books Ltd, 2017. ISBN: 978-0-241-98038-5.

[10] Cornelis P. Pieters. "Patterns, Models, Complexity; Notes on Mapping Patterns in Analysis of Complexity". In: *Emergence: Complexity & Organization (E:Co)* 12.4 (Dec. 2010), pp. 57–77.

[11] Cornelis P. Pieters. *Into Complexity: A Pattern-oriented Approach to Stakeholder Communications*. Boca Raton: Dissertation.Com, Mar. 2010. ISBN: 1-59942-305-7.

[12] Sang Gyu Kwak and Jong Hae Kim. "Central limit theorem: the cornerstone of modern statistics". In: *Korean Journal of Anesthesiology* 70.2 (Apr. 2017), pp. 144–156. ISSN: 2005-6419. DOI: 10.4097/kjae.2017.70.2.144. URL: https://pmc.ncbi.nlm.nih.gov/articles/PMC5370305/ (visited on 01/06/2026).

[13] George H. Weiss and Robert J. Rubin. "Random Walks: Theory and Selected Applications". en. In: *Advances in Chemical Physics*. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/9780470142769.c John Wiley & Sons, Ltd, 1982, pp. 363–505. ISBN: 978-0-470-14276-9. DOI: 10.1002/9780470142769.ch5. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/9780470142769.ch5 (visited on 01/06/2026).

[14] Karl Pearson. "The Problem of the Random Walk". In: *Nature* 72 (July 1905). ADS Bibcode: 1905Natur..72..294P, p. 294. ISSN: 0028-0836. DOI: 10.1038/072294b0. URL: https://ui.adsabs.harvard.edu/abs/1905Natur..72..294P (visited on 01/06/2026).

[15] G. L. Squires. *Practical Physics*. 4th ed. Cambridge: Cambridge University Press, 2001. ISBN: 978-0-521-77940-1. DOI: 10.1017/CBO9781139164498. URL: https://www.cambridge.org/core/books/practical-physics/E2FF87D0F807136DA3BD343F79673E07 (visited on 01/06/2026).

[16] John Wallis. *The Arithmetic of Infinitesimals: John Wallis 1656*. en. Google-Books-ID: iBaDonch-WNcC. Springer Science & Business Media, Aug. 2004. ISBN: 978-0-387-20709-4.

[17] Sergey Khrushchev. "A Recovery of Brouncker's Proof for the Quadrature Continued Fraction". In: *Publicacions MatemÃ tiques* 50.1 (2006), pp. 3–42. ISSN: 0214-1493. URL: https://www.jstor.org/stable/43736831 (visited on 01/06/2026).

[18] Cornelis Pieter Pieters. *Complexity Thinking: Science in the Age of Alternative Truths*. English. Austin Macauley Publishers, Apr. 2024. ISBN: 978-1-398-49019-2.

[19] Anup Goel. *Metrology & Quality Control: Science of Measurement*. English. Independently published, 2020. ISBN: 979-8-6955-8618-3.

[20] Karl R. Popper. *The Logic Of Scientific Discovery*. FIRST HARPER TORCHBOOK Edition. HARPER TORCHBOOK, 1965. ISBN: 06-130576-6.

[21] Gerard de Vries. *De ontwikkeling van wetenschap: Een inleiding in de wetenschapsfilosofie*. Wolters-Noordhoff, 1984. ISBN: 90-01-92364-X.

[22] Douglas Adams. *The Hitchhiker's Guide to the Galaxy Illustrated Edition*. English. London: Pan Macmillan, 2021. ISBN: 978-1-5290-4613-7.