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The Illusions of Reality

The illusion that what we see now exists at this moment, the illusion that the world exists only at the present moment, the illusion that time flows, the illusion that the world and physical bodies are three-dimensional, the illusion that the perceived motion and change of three-dimensional bodies are really happening, the illusion that…

Recent ideas of extra dimensions, parallel universes, and the multiverse are examples of radical views of reality which are now being considered in fundamental science. In the absence of experimental verification, it is not surprising that these hypotheses have not affected the commonly held view of the world. However, there has been a continued resistance to the implications of even proven advancements in physics from a hundred years ago for our view of what exists.

Since Heraclitus, the predominant view for twenty-five centuries has been presentism. According to this worldview, what is real is the present or everything believed to exist at the constantly changing present moment often called 'now.' During the past centuries people have been holding this view of reality despite the steadily growing number of arguments, which demonstrated that it is rather an illusion. There had been no change even when the arguments against presentism became insurmountable in 1905 when Albert Einstein formulated the special theory of relativity and particularly in 1908 when Hermann Minkowski revealed its profound physical meaning – that all moments of time have equal existence since they form the fourth dimension of what Minkowski called the absolute four-dimensional world in which the time dimension and the three space dimensions are inseparably amalgamated. We now call this world Minkowski spacetime, or simply spacetime.

A century after the advent of the theory of relativity the die hard presentist view is still very much alive and continues to be held not only by the general public, but also by some scientists and philosophers. The main reason for this situation seems obvious – we are never taught in school what the world is according to the proven scientific advancements. Everyone rediscovers presentism by the same apparently self-evident mechanism: we are aware of ourselves and the world at the moment 'now' and assume that the world itself exists only at this moment. But such an assumption does not necessarily follow from what we perceive exactly as it does not follow that what exists is only the small region of space around us which we perceive.

Educators should be concerned and feel responsible when in the 21st century most members of our society still hold an inadequate view of the world, which contradicts not just a theory – the theory of relativity – but most importantly it contradicts the experiments that led to its discovery and the experimental evidence which confirmed its basic predictions. Colleges and universities could accept the responsibility to deal with the gap in our education by offering courses on the history and foundations of science centered on the implications of the major scientific achievements for our view of the world. Such courses should also deal with another closely related and crucial issue – that a scientific theory, whose predictions have been repeatedly confirmed by experiment in its domain of

applicability, will never be disproved in that domain by a more modern theory. The need for a thorough understanding of this issue arises from an occasional temptation that we should not worry about the implications of a scientific theory for our worldview since sooner or later it would be replaced by a more modern theory which might not have such implications.

Let me briefly outline the major facts throughout the last two and a half millennia which have been increasingly indicating that the presentist view is nothing more than an illusion.

Since ancient times philosophers have been suspecting that what our senses tell us about the world might not necessarily reflect the world the way it is. Perhaps the most famous example is Plato's allegory of the cave in his book *The Republic*. Prisoners can see only the shadows of real objects on the wall of the cave and believe that what they see are the real things. But when a prisoner is allowed to look towards the light, he sees the actual objects and realizes that "what he saw before was an illusion."

Plato had been strongly influenced by the ideas of the Eleatic school of philosophy, whose representatives were Parmenides, Zeno, Melissus, and perhaps Xenophanes. The Eleatic philosophy is a unique case in the intellectual history of our civilization, because twenty-five centuries ago the Eleatics had more trust in reason than in what appears to follow from our perceptions. The essence of the Eleatic view had been developed by Parmenides in his poem "Peri Physeos." It presents two paths of knowledge – one leading to the truth (the way of Truth), the other to the opinions of men (the way of Opinion). The second path of knowledge deals with the world of our perceptions. This shows that the Eleatic philosophy did not deny what we perceive, but held that it is rather illusory and is therefore not revealing the ultimate reality.

However, the Eleatics denied what had been taken as self-evident by Heraclitus and other philosophers – that what exists, exists only at the present moment. Such an understanding of our everyday experience, according to the Eleatic philosophers, meant that what was in the future and did not exist, comes into existence by becoming present, and what existed as present goes out of existence by becoming past. Parmenides believed that nothing could come into or go out of being (existence) because it would contradict a basic postulate – being exists, non-being does not exist (or in less abstract form – something cannot arise out of nothing). Parmenides held that this postulate (which is an ancient form of the fundamental idea of conservation) could be deduced from what we perceive: "there are signs aplenty that, being, it is ungenerated and indestructible, whole, of one kind and unwavering, and complete. Nor was it ever, nor will it be since now it is, altogether, one continuous." The Eleatics argued that their view of the world as an eternal existence followed from their basic postulate since nothing could come into being and nothing could go out of being. If something were to come into being it should come either from being or from non-being, but neither of these alternatives is possible since being cannot become being (it is already being), whereas non-being does not exist. By the same argument, nothing can go out of existence.

One does not need to agree with the Eleatic arguments to realize that not only does the presentist view have great difficulty explaining how something can come into and go out of existence, but also that such a view appears to be self-contradictory. It seems Aristotle was the first who realized that self-contradiction when he resolved the paradox *Dichotomy* formulated by the Eleatic philosopher Zeno designed to demonstrate the unreality of motion. Zeno argued that an object moving from a point A to a distant point B would never reach B since it would need an infinite amount of time, first to travel half of the distance AB, then half of the remaining half, and so on to infinity. Aristotle showed that Zeno had arrived at the paradox, because he explicitly presupposed that space was divisible to infinity, but implicitly assumed that time was not infinitely divisible (if both space and time are infinitely divisible, there is no paradox – if a distance of one meter is traveled by a body for one second, the body will travel half a meter for half a second and so on, and will not need an infinite amount of time to reach the end point B). Aristotle wrote about Zeno's implicit assumption that time is not infinitely divisible: "But this is false, because time is not composed of indivisible nows, and neither is any other magnitude." However, when Aristotle discussed the nature of time itself – that of all times (past, present, and future) only the moment 'now' is real – he arrived at the opposite conclusion: "The present… is necessarily indivisible." He realized that he had no choice but to talk about "the present *indivisible* now" in order to avoid a contradiction in terms – if the moment 'now,' which by definition is wholly present, were divisible, it would contain past, present, and future moments.

The very fact that Aristotle, who single-handedly created the science of logic, was led by the presentist view to the contradiction – the present moment is both divisible and indivisible – implies that its basic assumption of the sole existence of the moment 'now' is wrong. Aristotle seems to have tried to identify the cause of that contradiction. An indication of such an attempt is his doubt on whether the division of time into past, present, and future reflected an objective fact or that division had something to do with the mind: "It might be wondered whether or not there would be time if there were not mind."

Sixteen centuries ago Augustine also investigated the nature of time and like Aristotle faced the same paradoxical situation about the duration of 'now,' but unlike him explicitly concluded that the division of time into past, present, and future does not reflect an objective feature of the world and therefore should belong to the mind: "it is inexact language to speak of three times – past, present, and future... In the soul there are these three aspects of time, and I do not see them anywhere else."

One might be tempted to say that Aristotle and Augustine could have avoided the paradox with the duration of 'now' by assuming that it is zero. Aristotle seems to have regarded this option as obviously unacceptable and had not even bothered to discuss it. And indeed, on the presentist view that option is ruled out – if the duration of the present moment were zero it follows that even 'now' would not exist (zero duration of 'now' means non-existence) and therefore no part of time would exist.

To see even better why the presentist view is self-contradictory, note that presentists have been taking for granted two things: (i) only the present moment is real, and (ii) the present

(the world at the moment ‘now’) is three-dimensional. As the duration of the moment ‘now’ cannot be zero it should be finite. But a finite ‘now’ should not be divisible because otherwise it would constitute a contradiction in terms. The only remaining option is a finite ‘now,’ which is indivisible. Most probably, Aristotle would have strongly objected to this option even because it would mean that Zeno would have succeeded in proving that motion was impossible. But this is not the only problem arising from a finite indivisible ‘now.’ It also challenges the second basic assumption in the presentist view – that physical objects and the world are three-dimensional, which has been regarded as self-evident since Aristotle. The challenge is best comprehended by assuming for the sake of the argument that ‘now’ lasted, say, ten seconds. This would mean that physical objects and the world would not be three-dimensional since they would exist ***at once at all moments*** of the ten-second ‘now’ and would be therefore ***extended in time***. So, in order for the moment ‘now’ to exist it should be finite and indivisible, which means that the world would not be three-dimensional, but extended in time; the world would be three-dimensional only if the duration of ‘now’ were zero, which means that time would not exist at all.

A major illusion involved in the presentist view was realized in 1676 when Olaf Roemer measured that the speed of light was finite. Then it became clear that the present is not what we see simultaneously at the moment ‘now,’ because light reflected or emitted from objects needs some time to reach our eyes. Therefore what we see right now is all past. The ‘three-dimensional’ mental images in our mind of which we are aware at the present moment represent objects at past moments of their histories. For instance, the star in the night sky which we see now is an image representing a star at a moment of its existence that might be millions of years in the past.

After Roemer’s discovery the presentist view had been corrected but the link between existence and the present moment had been preserved. The present (or the three-dimensional world at the moment ‘now’) had been defined in terms of simultaneity – everything that exists ***simultaneously*** at the present moment. It is this seventeen-century version of presentism that is still widely held today despite two major arguments against it which have been raised since then.

The first argument deals again with the belief that of all moments of time it is only the present moment that exists. It is a well-known fact that no scientific theory describing the physical world regards a given moment of time as being privileged by physical phenomena. Due to this fact alone some scientists and philosophers have been suspecting that the present moment appears special not because it is only ‘now’ that exists, but because of our awareness at the present moment of our own existence and the existence of the world. No proponent of presentism – a scientist or philosopher – has ever been able to answer the obvious and crucial question: “What is the physical evidence for the sole existence of the present moment if science has failed to find it in the last three centuries?’’

The second argument is the most powerful that one can think of. It demonstrates that presentism contradicts both the experiments which led to the discovery of the special theory of relativity by Einstein in 1905 and the experimental evidence which confirmed its kinematic predictions. Hendrik Lorentz and Henri Poincaré were close to discovering the

theory of relativity, but it was Einstein who succeeded because he managed to extract some partial information hidden in the experimental fact that physical phenomena are the same for all inertial observers (observers who move with constant velocities relative to one another). This experimental fact is called the relativity principle and was first discovered by Galileo in the 17th century for the case of mechanical phenomena. But at the turn of the 19th and 20th century Albert Michelson and Edward Morley performed an experiment involving light which demonstrated that not just mechanical, but all physical phenomena known at the time are the same for all inertial observers. Einstein noticed that the experimental facts, which the relativity principle captures, can be explained if the inertial observers in relative motion had their own times and therefore their own classes of simultaneous events. But Einstein stopped there by merely stating that time and simultaneity were not absolute but relative and did not offer any explanation of what that meant.

The profound physical meaning of the relativity postulate and relativity of time and simultaneity was revealed by Hermann Minkowski in 1908. He completely decoded the message hidden in the relativity postulate. Minkowski acknowledged that the credit of first recognizing clearly that the times of observers in relative motion should "be treated identically belongs to A. Einstein. With this, time as a concept unequivocally determined by the phenomena was deposed from its high seat. Neither Einstein nor Lorentz made an attack on the concept of space." It was Minkowski who made the attack on space. He pointed out that as observers in relative motion have different times and therefore different classes of simultaneous events, they necessarily have different spaces as well (as a space constitutes a class of simultaneous events): "We should then have in the world no longer *the* space, but an infinite number of spaces, analogously as there are in three-dimensional space an infinite number of planes."

Therefore, what the experimental fact – physical phenomena are the same for all inertial observers – has been trying to tell us about the world, is that there are no privileged inertial observers. All inertial observers are equivalent since each of them describes the phenomena in exactly the same way – in his or her own space and time. Precisely because of this, physical phenomena are the same for the inertial observers in relative motion. But as Minkowski demonstrated many spaces and times are possible only in an absolute four-dimensional world whose fourth dimension is time. Minkowski argued that this world, in which all moments of time equally exist, was the adequate relativistic view of reality since it was deduced from experimental physics (from the experimental fact captured in the relativity principle that no absolute motion can be discovered as confirmed by the Michelson-Morley experiment): "The views on space and time which I wish to lay before you have sprung from the soil of experimental physics. Therein lies their strength."

That presentism contradicts the theory of relativity is most clearly seen in the case of relativity of simultaneity since this view is defined in terms of absolute simultaneity – as everything that exists simultaneously 'now.' Assume for a moment that presentism is indeed the correct view of the world. Then what exists would be the present, i.e. a single (absolute) class of simultaneous events, which means that all observers in relative motion would share the same class of absolutely simultaneous events. Therefore, if presentism

were correct, simultaneity would turn out to be absolute in contradiction with the theory of relativity.

As relativity of simultaneity is deduced from the experiments reflected in the relativity principle, the fact that presentism contradicts relativity of simultaneity means that it contradicts the experimental evidence that led to the theory of relativity. But this is not the only contradiction. Relativity of simultaneity was also tested experimentally through two specific manifestations of it – length contraction and (reciprocity of) time dilation. Time dilation has been constantly tested by the Global Positioning System, but both effects were confirmed in a single experiment – the so called muon experiment. That is why by contradicting relativity of simultaneity presentism contradicts that relativistic experimental evidence. Presentism also contradicts the experiments which confirmed another relativistic effect – the twin paradox. To convince yourselves that this is really the case, assume for a moment the opposite – that presentism were correct and each of the twins existed only at his moment 'now' as a three-dimensional body – and you will see that this relativistic effect would be impossible.

According to the theory of relativity reality is a four-dimensional world (a block universe), which contains the whole history in time of what we perceive as an evolving three-dimensional world since all moments of time have equal existence due to their belonging to the fourth (time) dimension. As a macroscopic physical body is a four-dimensional worldtube (the body equally existing at all moments of its history), what we perceive as changing and moving three-dimensional macroscopic bodies is, in reality, a forever given web of worldtubes. The relativistic view of the world is totally counter-intuitive but it inescapably follows from the experimental evidence as Minkowski demonstrated. The four-dimensional world of relativity can be visualized by a rough analogy. Imagine that you watch an old movie and your intuition tells you that what is real is the constantly changing image on the screen, but you know well that what is ultimately real is the whole story of the movie entirely given on the film strip.

In the four-dimensional world implied by relativity, the privileged status of the present moment and its constant change turned out to be minddependent as the Eleatics anticipated, Aristotle suspected, and Augustine conjectured. What seems to be the sole explanation of our feeling that only 'now' exists and time flows, which is compatible with the theory of relativity, was given by Hermann Weyl. According to him it is the mind which creates that feeling: "The objective world merely exists, it does not happen; as a whole it has no history. Only before the eye of the consciousness climbing up in the world line of my body, a section of this world "comes to life" and moves past it as a spatial image engaged in temporal transformation."

Despite the overwhelming evidence supporting the relativistic view of reality, the resistance against it started almost immediately after the advent of the theory of relativity, which prompted Arthur Eddington to write in 1920: "However successful the theory of a four dimensional world may be, it is difficult to ignore a voice inside us which whispers: "At the back of your mind, you know that a fourth dimension is all nonsense." I fancy that that voice must often have had a busy time in the past history of physics. What nonsense to

say that this solid table on which I am writing is a collection of electrons moving with prodigious speeds in empty spaces, which relatively to electronic dimensions are as wide as the spaces between the planets in the solar system! What nonsense to say that the thin air is trying to crush my body with a load of 14 lbs. to the square inch! What nonsense that the star cluster which I see through the telescope obviously there now, is a glimpse into a past age 50,000 years ago! Let us not be beguiled by this voice. It is discredited."

A century after Minkowski we all should finally face the facts which show that what appears to be self-evident to us – that the world exists only at the moment 'now' – is, as Einstein put it, "only an illusion, however persistent." It is true that the view of reality which is consistent with modern science poses great challenges of its own. But taking refuge from the blinding light of truth back into the deceivingly safe and comfortable cave of ignorance should not be an option for anyone in the 21st century.

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