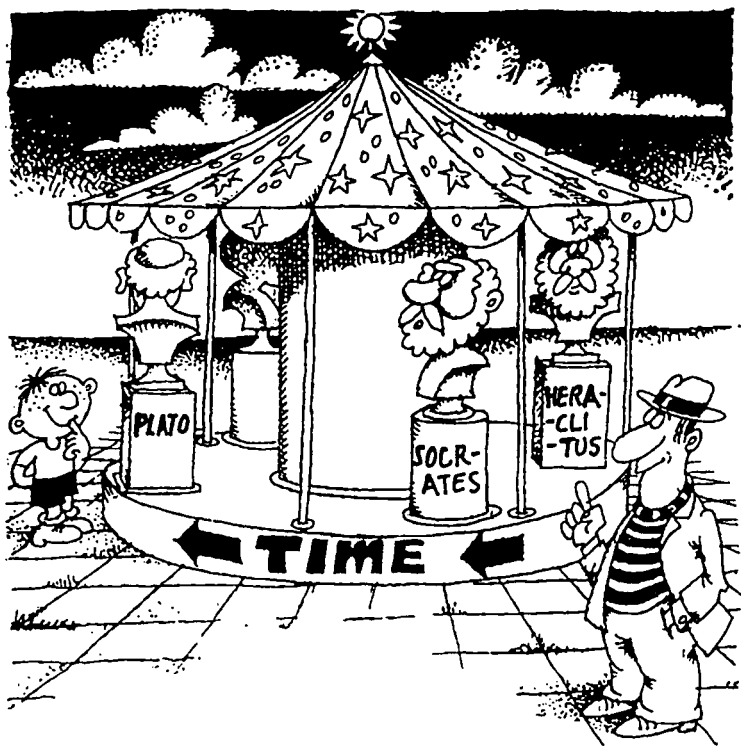


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Igor D. Novikov
Excerpt
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Origins of thinking about time



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Ever since I started reading popular science books on physics, I have regarded it as self-evident that time is synonymous with empty duration, that it flows like a river and carries in this flow all events without exception. This stream is unalterable and unstoppable, going in a never-changing direction: from the past to the future.

It seemed that this interpretation, given our knowledge about the surrounding world, was unavoidable.

I learnt only many years later that people had not always held such or similar intuitive notions – far from it.

Heraclitus of Ephesus, a philosopher in ancient Greece who lived at the end of the 6th century BC, appears to have been one of the first thinkers of antiquity who set forth a belief that everything in the world changes and that this changeability is the highest law of nature (*all things are in process and nothing stays still*). Heraclitus set out his view in the book *About Nature*, of which only a few fragments survived and reached us (*Cosmic Fragments*).

Heraclitus taught that the world is full of contradictions and variability. All things undergo changes. Time flows relentlessly, and everything that exists moves with this unstoppable stream. The skies move, physical bodies move, a human's feelings and conscience move as well. 'You cannot enter twice into one and the same river' said he, 'because its water is constantly renewed.' Things come to replace other things. 'The fire is alive through the death of the earth, the air is alive through the death of the fire, the water is alive through the death of the air, the earth is alive through the death of the water.'

From the high ground of our current knowledge, we tend to look down with irony on the chain of births and annihilations described by Heraclitus. Nevertheless, he gave a very impressive picture of the general changeability of all things in time: '... everything is changing in the all-encompassing circulation in the creative game of the Eternity'.

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Science was just emerging in those distant centuries. The thinkers of that period had not yet formed the concept of directed progressive development. People rather observed the cyclic organization of phenomena in the surrounding nature. Day was replaced with night, to return again in the morning. One season was replaced with the next and was resumed at the end of the annual cycle. The motion of heavenly sources of light was cyclic too.

As a result of these constantly observed phenomena, time was not perceived as an omnipresent unidirectional flow - as a 'river of time'. Time was pictured rather as a cyclic alternation of opposites. For instance, the Greek mathematician and philosopher Anaximander of Miletus (c. 610-547 BC) taught that the primal basis of any existence was 'infinity'. Its eternal motion generates the opposites: heat and cold, dryness and moisture; then everything returns to the original state. Anaximander stated:

The primal essence of the existing objects is also the fact that when they perish, they return as dictated by necessity. Indeed, they justly reimburse one another in a prescribed time as a compensation for damages.

I believe now that this is a very original interpretation of time and changeability, one that relates them to the concepts of justice and balance.

However, the idea of only temporary cyclic changes and the invariance of the totality of the existing world reigned in the minds of thinkers during many centuries. People believed that all phenomena change cyclically, returning 'to their proper orbits'.

The famous idealistic Greek philosopher Plato (427-347 BC) advanced interesting and profound ideas concerning time.

Plato was a pupil of Socrates (470-379 BC), known as 'the wisest of Hellenes (Greeks)'. He belonged to a very rich and old family whose origins can be traced back to the last king of Athens. We

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know very little about the life of Plato and most other philosophers of that period. Reliable facts are interspersed with legends and even obviously apocryphal anecdotes. We know that Plato received a complete course of training under the guidance of the best teachers. This means that he studied grammar, music and gymnastics. Then he began to write poetry. In 407 BC, the twenty-year-old Plato met Socrates and devoted himself completely to philosophy.

Socrates' method of teaching was to conduct a free discussion with anyone willing to listen to him. The rulers banned such talks with young pupils but the philosopher held to his principles and patriotism and ignored the orders. His unfettered disputes with pupils had a tragic finale: he was accused of godlessness and perverting the young, and incarcerated. Friends offered help to escape from jail, pupils (including Plato) collected money for bail. However, Socrates chose a proud line: he rejected running from prison, was given a harsh sentence and had to drink a phial of poison.

After his teacher's death, Plato moved to Megara and continued studying philosophy. He traveled extensively, attempting to influence the rulers into creating an 'ideal state' run by philosophers. These attempts failed utterly. Some (unreliable) evidence claimed that he had even been sold into slavery but freed himself and returned to Greece. Having regained Athens in 386 BC, Plato founded his school of philosophy that he called the 'Academy'.

Plato taught that the world that people observe and study is not the 'true world' but is merely its external incarnation. Both heavenly bodies and bodies on the Earth are but 'pale shadows' of some ideal objects which constitute the true world: 'These shadows are imperfect and changeable'. Plato taught that the 'true world' consists of abstract essentials (he called them 'ideas'). The 'ideas', these 'spiritual entities', are impeccably perfect and unchangeable in principle. Ideas exist not in our material Universe, not in space and time, but in the ideal world of complete perfection and eternity.

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The true existence, said Plato, is the ideal existence. For example, the true abstract world includes not a specific thing, say, a wooden table of certain color, shape etc. but the abstract notion of 'table'. This notion is the 'idea of the table'.

Obviously, this idea cannot change. The eternal unchangeability of ideas resembles the properties of geometric figures: triangles, circles, pyramids. Their properties also remain absolute, they also exist in the abstract world of one's mind. However, Plato postulated that the true reality was this abstract world.

According to Plato, the Creator (Demiurge) conjured up the visible world by 'copying' these ideal objects. Each body tends to resemble the original but is inevitably changeable, has a beginning and an end. As a result, the 'pale shadows' fail to reproduce their ideals. The ideals personify eternity, while the world as we see it constitutes constant changeability. To put things in order and to smoothen the contradiction, the Demiurge devised time. 'His idea was to produce a non-static resemblance of eternity: while arranging the heavens, He created for the eternity (which stays unified) an equally eternal reflection which moves from a number to a number that we call time.'

Therefore, by analogy with the bodies in the surrounding world that we perceive by vision and touch and which are, according to Plato, imperfect copies of their ideal originals in the world of ideas, time is an imperfect 'model', an image of the ideal eternity. Time is perpetually flowing, thus imitating the unchangeable perfect abstract eternity of the abstract world of ideas.

This sounded very beautiful. Plato even thought up a mechanism for time to arise in the world created by God. Time, he said, is born in the motion of heavenly bodies, in the perpetual and unchangeable cyclic motion of the Sun, the Moon and the planets that man observes. In fact, Plato identified time with this cyclic motion.

Since the motion of heavenly bodies is cyclic, time also appeared

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to be cyclic, running on a circle. According to Plato, everything in our world repeats itself after a large segment of time. (Plato even indicated the length of this period: 36 thousand years.)

So many centuries separate us from antiquity that it is often very difficult to realize the level of knowledge of that time and the style of reasoning typical of that culture. It is therefore often almost impossible to appreciate the true measure of the scientific genius of a thinker in antiquity who made a bold step on the infinitely long road to uncovering the truth. For these reasons, and also owing to the paucity of reliable data, it is even more difficult now to reconstruct the complicated, multifaceted personalities of the philosophers, their far-from-simple life stories.

At that period, sciences were not divided cleanly into branches, no science could be distinguished from the all-encompassing philosophy, psychology and ethics. The knowledge, the feelings, the social and ethical positions often intertwined and affected one another. Plato chose for his writings the form of dialogues; in all likelihood, they were not a systematic presentation of his ideas, meant to follow a previously thought-out plan. The dialogues were written at different periods of Plato's life and at least some of them were stimulated by his debates with sophists (who preached intellectual anarchy) or other opponents, and by various problems in his life. The dialogue in these debates is always led by Socrates.

Plato's points of view changed with time. While still a pupil of Socrates, he believed that a philosopher lives to achieve cognition of abstract truths by way of free exercise of mental power. This cognition leads to happiness and is independent of external circumstances. Following Socrates, he postulated that the evil in the world stems from the ignorance of people, from their separation from the truths.

The death sentence on the obviously innocent Socrates had shaken Plato, and his outlook changed. He came to the conclu-

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sion that a world with this unbearable amount of malice cannot be the true one. The true world is the realm of perfect ideas. In this period, Plato was very skeptical about the view that teaching people what is good was the philosophers' goal. He believed that people were incorrigible. In one of his dialogues he painted a portrait of the principal accuser of Socrates. This anti-hero proclaimed that only government employees were true teachers of good while the so-called sages were merely malicious saboteurs of the foundations of society. In this dialogue, Socrates asked whether the anti-hero was acquainted with sages, and received the answer that no, he was not, nor would he wish to be, but that he strived to inflict as much harm on them as possible...

At later stages of his life, Plato tried to create in his writings a model of a state that he would consider as the 'ideal' one, the state ruled by philosophers; in fact, this was described as a state with slavery and wars, where Greeks were placed unquestionably above all the others (the barbarians). Later Plato made attempts to actually change the social structure by influencing the rulers, but in this, as I have already mentioned, he failed completely.

In his last book, *The Laws*, which Plato most probably wrote in his old age, he totally reneged on the striving of his younger years for truth and fairness. This is one treatise of Plato where the shining image of Socrates is not central at all; in fact, the teacher is not even mentioned. The spirit of this work is completely opposite to Socrates' principles.

The Codex of Laws that Plato compiled for the future 'ideal state' on Crete incorporated criminal persecution of 'magicians', the death sentence to a slave who failed to inform the authorities about a 'violation of social serenity', the death sentence to anyone who would dare to criticize the social order protected by the authorities and the official religion. In this way, Plato at the end

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of his life, shifted to the position of Socrates' accuser, anti-hero, whom Plato had attacked before.

Plato was one of the greatest thinkers. Later generations tend to idealize the image of a great man. However, even great personalities are not always entirely consistent. More often than not, they are complicated and contradictory, and change in response to external influences. They are simply human. A well-known German philologist and expert on Plato's work G. Ast (1778-1841), driven by the noblest intentions, went out of his way trying to classify *The Laws* as a fake text which is only attributed to Plato. Alas, this is most likely Plato's true work. We have for this the words of Aristotle of Stagira (384-322 BC), who was the most famous of Plato's pupils. The contradictions we find in Plato, his very complicated life and the undisguised reactionary nature of some of his statements, by no means detract from his tremendous contribution to science and philosophy.

Let us return to the problem of time. Aristotle held the same view on the cyclic nature of time as Plato, his teacher, had. Aristotle, one of the greatest scientists of ancient Greece, was an illustrious personality. His father was a doctor at the royal court of the Macedonian king. The father taught his son medical subjects and philosophy, wishing for Aristotle to inherit his position at court. Life changed these plans drastically. Having lost both parents quite early, the eighteen-year-old Aristotle went to Athens and entered Plato's Academy. He very soon mastered the philosophy of his teacher and rose to an independent position. His views deviated considerably from those of his teacher. Immediately after Plato had died, Aristotle left Athens. In 343 BC the Macedonian king, Philip, entrusted Aristotle with the education of his son Alexander, the future famous commander, Emperor Alexander the Great. The ennobling influence of Aristotle must have been quite strong, despite the atmosphere of plots and intrigues that reigned in the

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royal palace. Philip and Alexander felt immense gratitude to Aristotle, richly rewarded his services and rebuilt the ruined Stagira, his native city. Later various conspiracies destroyed the friendly relationship between Alexander and Aristotle.

But before that, Aristotle had returned to Athens in 334 BC and founded his own school, known as the Lyceum of the Peripatetic. The name of the school may have been connected with Aristotle's habit of constantly walking during his lectures.

After Alexander's death, the party of Independent Greece resisted Macedonian rulers and thus regarded the former teacher of Alexander the Great as a dangerous influence; furthermore, Aristotle enjoyed great respect from the young generation surrounding him. Aristotle was thus accused of godlessness; this stratagem was used against scientists by their enemies both before and also many centuries after Aristotle's time, and proved to be very convenient, since it was easily accepted by the ignorant populace. Aristotle realized that a just trial was impossible and that he would share Socrates' fate unless he decided to flee. He did leave Athens at the age of 62 and died fairly soon after.

It appears from the remarks of his contemporaries that Aristotle had a sarcastic wit and a very sharp tongue. His witty speeches were meant to ridicule his opponent, and he was cool and jocular. If we add to this that he was short, wizened, short-sighted and had a lisp, we can easily imagine that he had no difficulties in creating enemies.

It appears that Aristotle made no attempt to be delicate in his arguments and in demonstrating the power of his reasoning. We do not know whether this behavior was deliberate or unconscious. Incidentally, many centuries later another genius – Sir Isaac Newton – formulated at a relatively young age (he was 27 at the time) a different principle which stated, roughly, that needlessly parading one's superior intellect would only harm whatever work was being

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undertaken. He wrote in a letter to an acquaintance in Cambridge that you stand to gain little or nothing by appearing to be wiser or less ignorant than the society around you.

Perhaps, these very different attitudes towards social relations reflect not the distance of thousands of years but the differences in temperament and, generally, the fact that just as ordinary people, all geniuses are vastly different.

Aristotle left a tremendous imprint on all later developments in science and philosophy. His writings gave a summary of the current status of the whole of science and greatly contributed to some of its fields. In contrast to Plato, Aristotle rejected the notion of a non-material time-independent world of ideas. He believed that the world that we observe by vision and touch was real. Aristotle regarded physics as the science treating changing objects that exist in the real world. This distinguishes physics from mathematics which studies inherent, unchanging properties of numbers and shapes. Nonetheless, his physics remained a contemplative science.

According to Aristotle, the primary properties of matter are opposites: 'warm' and 'cold', 'dry' and 'moist'; the primary elements are earth, air, water and fire. To these he added the most perfect element, the ether. Aristotle taught that the main elements - earth and water - tend to move 'downward', towards the center of the Universe (this was his explanation of weight); we would say that they are subject to a force that pulls them down. Conversely, air and fire tend to rise up (in our language, we would say that a 'lifting force' acts on them). It is of interest that the separation of the contents of the Universe into 'physical matter' and 'interaction forces' survived in physics to our days, even though they came to mean very different things.

Aristotle taught that the Earth was spherical and stationary, and that it was located at the center of the Universe. He taught that the Moon, the Sun and the planets are fixed to crystal spheres and