The Decline of Science

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Abstract

Science (from Latin *scientia*, meaning knowledge) is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions. An explanation is a set of statements which clarify the relations among causes, context, and consequences of facts. Explanations may establish rules or laws which allow to formulate predictions. Consequently, *relations* (among causes, context and consequences) are at the basis of explanations and predictions and, when relations are studied in a replicable and objective way, it is possible to talk about science.

1. The dawn of science

The first traces of science are found in Mesopotamia and date back to 3500 B.C., when records with extremely thorough numerical data were kept for analyses. The eldest account on scientific methodology dates back to 1600 B.C., when an Egyptian medical text,[3] a surgical treatise on trauma which describes 48 cases of injuries, fractures, wounds, dislocations and tumors, presented the following phases: examination, diagnosis, treatment and prognosis. This treatise displays strong similarities with the modern scientific method and played a significant role in the development of the empirical methodology, based on observations and experimentation.[4] By the middle of the 1st millennium B.C., the first refined mathematical tools for the description of astronomical phenomena were developed in Babylonia, giving birth to the scientific approach in astronomy. All subsequent varieties of scientific astronomy, in the Hellenistic world, in India, in Islam, and in the West depend upon Babylonian astronomy.[5]

But it was in Greece, with Thales of Miletus[6], that the earliest forms of rational theoretical science were developed around 600 B.C.. The rational approach posits that reason alone can mark the truth or falsity of propositions. Thales attempted to explain natural phenomena without reference to mythology, supernatural and religion, proclaiming that every event had a natural cause. Thales was tremendously influential and almost all the Pre-Socratic philosophers followed him in the attempt to provide explanations without reference to mythology. Thales' rejection of mythological explanations became a fundamental element of the scientific process. Around 500 B.C. Leucippus developed the theory of atomism, according to which everything is composed of imperishable,

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[3] the in Ancient Egypt Edwin Smith Papyrus, named after the dealer who bought it in 1862.
[4] In the empiricist view, one can claim to have knowledge only when one has empirical evidence.
[5] Aaboe A (1974), *Scientific Astronomy in Antiquity*, Philosophical Transactions of the Royal Society 276 (1257): 21–42.
[6] Thales of Miletus (624 –546 B.C.) was a pre-Socratic Greek philosopher from Miletus in Asia Minor, and one of the Seven Sages of Greece. Many regard him as the first philosopher in the Greek tradition.

indivisible elements that he named atoms. This idea was elaborated in greater details by his pupil and successor Democritus.[7] They were both thoroughly materialists, believing everything to be the result of deterministic laws. Similar atomist ideas emerged independently among ancient Indian philosophers of the Nyaya school of logic and the Buddhist atomism school, that flourished in the Indian subcontinent during the 4th century B.C.

Around 350 B.C. Plato[8]and his most-famous student, Aristotle[9], laid the foundations of Western deductive reasoning in science. Aristotle introduced a methodology which involved both inductive and deductive reasoning. For Aristotle, universal truths can be known from particular things via induction, but induction by itself does not account for scientific knowledge. Induction provides the primary premises to scientific enquiry, by generalization, but it does not provide a causal explanation. The methodology which Aristotle devised, for the development of causal explanations, was the deductive reasoning based on syllogisms, which allows to infer new universal truths from those already established, through intuition. According to Aristotle, induction does not provide the basis for science, whereas intuition offers solid foundations. He believed that "*intuition is the originative source of scientific knowledge.*" Aristotle wrote that "*we do not have knowledge of a thing until we have grasped its why, that is to say, its cause.*"[10] He held that there are four kinds of causes: *material* causes, *formal* causes determined by the context, such as ratios that cause the octave, *efficient* causes which act as agencies, for example a carpenter for a table or a father for a boy and *final* causes such as the adult plant for a seed and the sailing for a sailboat.

In the 3rd and 4th centuries B.C., the Greek anatomist Herophilos (335–280 B.C.) used the experimental method in order to record data on dissections. He considered essential to produce knowledge starting from empirical observations and comparisons.

In the Islamic world it was common for scientists to be also artisans, expert instrument makers. They used the experimental approach to distinguish between competing scientific theories, as can be seen in the works of Jābir ibn Hayyān (721–815), who left nearly 3,000 treatises and articles in fields ranging from: cosmology, music, medicine, biology, chemical technology, geometry, logic and artificial generation of living beings. A total of 112 books are dedicated to the Arabic version of the Emerald Tablet, an ancient work that proved a recurring foundation of alchemical operations.

Ibn al-Haytham (965-1040), who has been described as the father of modern optics, combined observations, experiments and rational arguments to support his theory of vision. He showed that the ancient theory of vision, supported by Ptolemy and Euclid (in which the eyes emit rays of light used for seeing), and the theory supported by Aristotle (where objects emit physical particles to the eyes), were both wrong. Experimental evidence supported most of the propositions in his books and grounded his theories. Ibn al-Haytham used the scientific method to establish that light travels in straight lines: "*This is clearly observed in the lights which enter into dark rooms through holes. ...*

[7] Democritus (460 - 370 B.C.) was an influential Ancient Greek pre-Socratic philosopher.

[8] Plato (428 - 348 B.C.) was a philosopher, as well as mathematician, in Classical Greece and an influential figure in philosophy. He was Socrates' student, and founded the Academy in Athens, the first institution of higher learning in the Western world.

[9] Aristotle (384 – 322 B.C.) was a Greek philosopher and scientist born in Stagirus, northern Greece. At the age of eighteen, he joined Plato's Academy in Athens. His writings cover many subjects – including physics, biology, zoology, metaphysics, logic, ethics, aesthetics, poetry, theater, music, rhetoric, linguistics, politics and government.

[10]Falcon A. (2008), *Aristotle on Causality*, Stanford Encyclopedia of Philosophy 2008.

the entering light will be clearly observable in the dust which fills the air."[11] Ibn al-Haytham also explained the role of skepticism, and criticized Aristotle for his lack of contribution to the method of induction, which he considered to be the basic requirement for true scientific research.

The Persian scientist Abū Rayhān al-Bīrūnī (973-1048) used the experimental method in several different fields of inquiry, with emphasis on repeated experimentation. Bīrūnī was concerned with how to prevent systematic errors and observational biases, such as "*errors caused by the use of small instruments and errors made by human observers*." He argued that if instruments produce errors, then multiple observations must be taken, and arithmetic mean values used as the true measurement.

Ibn Sina (980 - 1037), Latinized as Avicenna, studied all the books of Aristotle, then available only in Arabic, and used them as the basis of his healing methods described in his famous book Al-Qanun, (The Canon of Medicine), that was widely used until the 17th century, when the rational-mechanistic methods were introduced and promoted in the West, following the complete change in scientific approach to nature and life. In The Book of Healing (1027), he diverges from Aristotle on several points: "*how does a scientist find the initial axioms or hypotheses of a deductive science without inferring them from some more basic premises?*" arguing that induction "*does not lead to absolute, universal, and certain premises*." In its place, he advocated "*a method of experimentation as a means for scientific inquiry.*" He was also the first to describe what is essentially the method of concomitant variations.

2. Duality

Although some knowledge of scientific methodology seems to have lingered in the ecclesiastical centers of western Europe, after the fall of the Roman empire, ideas on scientific methodology were reintroduced in the 12th century to Europe, via Latin translations of Arabic and Greek texts and commentaries. The lack of Latin translations had been due to several factors, including limited techniques for copying books, lack of access to the Greek texts, and few people who could read ancient Greek, while the Arabic versions were more accessible. Aristotle's newly translated views supported the notion of a personal God, which ended in the list of forbidden books in the Condemnations of 1210–1277. At the end of that same period, Thomas Aquinas (1225-1274) reconciled Aristotle viewpoints with Christianity, in his work Summa Theologica. But, in 1277 another more extensive condemnation was issued with the aim to clarify that God's absolute power transcended any principles of logic that Aristotle might place on it. More specifically, it contained a list of 219 propositions that violate the omnipotence of God, and included in this list twenty propositions by Thomas Aquinas. Their inclusion badly damaged Thomas's reputation for many years.

The first signs of conflict between science and the Church became clear with the results of the astronomical observations of Nicholaus Copernicus (1473-1543), which put the Sun at the center of the universe and showed the contradictions of the geocentric system, in which the Earth was placed at the center of the universe. Copernicus' work represented a huge innovation in the astronomical field, followed by Johannes Kepler (1571-1630), who, thanks to astronomical tables, arrived at the

[11] Alhazen (Ibn Al-Haytham) Critique of Ptolemy, translated by S. Pines, Actes X Congrès internationale d'histoire des sciences, Vol I Ithaca 1962, as referenced on p.139.

formulation of the three laws of planetary motion, developing the Copernican heliocentric model into a scientific model.

Giordano Bruno (1548 - February 17, 1600), an Italian Dominican friar and mathematician, famous for his cosmological theories, went even further. While supporting the heliocentric model, he proposed that the Sun is just one of the many stars moving in space, and claimed that an infinite number of inhabited worlds, identified as planets, orbit other stars. Beginning in 1593, Bruno was tried for heresy by the Roman Inquisition on charge of the denial of several core Catholic doctrines (including the Trinity, the divinity of Christ, the virginity of Mary, and Transubstantiation). The Inquisition found him guilty, and in 1600 he was burned at the stake in Rome's Campo de' Fiori. After his death he gained considerable fame as a martyr for science. Bruno's case is still considered a landmark in the rise of the duality between science and Christianity.

The duality between science and the Church is though symbolized by Galileo Galilei (1564-1642). Using the telescope which had just been invented, Galileo was able to empirically prove Copernicus' heliocentric hypothesis. A sequence of events brought Galileo into conflict with both the Catholic Church, for his support of Copernican astronomy, and the Aristotelians. In 1610, Galileo published his Sidereus Nuncius (Starry Messenger), describing the surprising observations that he had made with the new telescope, namely the phases of Venus and the moons of Jupiter. In 1616 the Inquisition declared heliocentrism to be heretical. Heliocentric books were banned and Galileo was ordered to refrain from holding, teaching or defending heliocentric ideas. Galileo went on to propose a theory of tides in 1616, and of comets in 1619; he argued that the tides were evidence for the motion of the Earth. In 1632 Galileo, now an old man, published his Dialogue Concerning the Two Chief World Systems, which implicitly defended heliocentrism, and was immensely popular. Responding to mounting controversy over theology, astronomy and philosophy, the Roman Inquisition tried Galileo in 1633 and found him "gravely suspect of heresy", sentencing him to indefinite imprisonment. Galileo was kept under house arrest until his death in 1642.

In the same period Francis Bacon (1561-1626) became one of the major assertors of the experimental method, courageously attacking the traditional schools of thought which were based on Aristotelian deductive logic. Bacon starts from empirical evidence to arrive at general laws. In order to produce objective knowledge, Galileo's and Bacon's scientific methods separated the observer from the observed. This approach totally transformed the nature and purpose of science. Whereas previously the purpose of science had been to understand nature and life, the purpose was now to control and manipulate nature. As Bacon said: "*Objective knowledge will give command over nature, medicine, mechanical forces, and all other aspects of the universe.*" In this perspective, the aim of science became that of enslaving nature and the organic concept of nature was soon replaced by the mechanistic concept of the world.

René Descartes (1596-1650) based his work on the idea that the "*book of nature*" had been written in mathematical characters. His aim was to reduce all physical phenomena to exact mathematical equations and he believed that nature could be described using simple motion equations, in which only space, position, and moment were relevant. "*Give me position and movement,*" he said, "*and I will build the universe.*" Among Descartes' greatest contributions was his *Analytical Method of Reasoning*, according to which any problem can be decomposed into its parts, and then reordered. This method lies at the foundation of modern science, and has been of great importance, permitting the development of scientific theories and complex technologies. Descartes' vision is based on the duality between two reigns, separate and independent: the reign of spirit, or *res cogitans*, and the reign of matter, or *res extensa*. This division between matter and spirit has had profound consequences on culture, leading to the separation of body and mind which still puzzles science and provided formal recognition to the split between science (res extensa) and religion (res cogitans). According to Descartes, matter and spirit are created by God, who is the creator of the exact order of nature that we see, thanks to the light of reasoning (res cogitans). However, in the following centuries the reference to God was omitted and reality was divided into the human sciences, linked to *res cogitans* and the natural sciences, which were an expression of *res extensa*. Descartes' vision described the material world as a machine which has no intentionality and no spirituality; nature functions according to mechanical laws, and every aspect of the material world can be explained on the basis of its position and movement. This mechanical vision was extended by Descartes to living organisms, in the attempt to organize a complete natural science. Plants and animals were considered simply as machines, whereas human beings were "inhabited" by a rational soul (*res cogitans*) linked to the body (*res extensa*) through the pineal gland, at the center of the brain. The human body, on the other hand, was similar to the body of an animal-machine. This highly mechanistic vision of nature was inspired by the high precision that was being achieved at the time by the technology and art of clock-making. Descartes compared animals to "clocks with mechanisms and springs" and extended this comparison to the human body, comparing a sick body to a badly build clock, and on the other hand, a healthy body to a well-constructed and perfectly functioning clock.

The duality between science and religion reached its maturity in the works of Isaac Newton (1642-1728). Newton was an English physicist and mathematician, who is widely recognized as one of the most influential scientists and as a key figure in the scientific revolution. His book *Philosophiæ Naturalis Principia Mathematica* (Mathematical Principles of Natural Philosophy), first published in 1687, laid the foundations for classical mechanics. Newton's Principia formulated the laws of motion and universal gravitation, which dominated scientists' view of the physical universe for the next three centuries. By deriving Kepler's laws of planetary motion from his mathematical description of gravity, and then using the same principles to account for the trajectories of comets, the tides, the precession of the equinoxes, and other phenomena, Newton removed the last doubts about the validity of the heliocentric model of the cosmos. This work also demonstrated that the motion of objects on Earth and of celestial bodies could be described by the same principles. Nonetheless, Newton was also an insightful and erudite theologian. He wrote many works that would now be classified as occult studies and religious tracts dealing with the literal interpretation of the Bible. He believed in a monotheistic God as the masterful creator, whose existence could not be denied in the face of the grandeur of all creation, and he held a Christian faith.

Before Newton the Church considered science a threat, but with Newton mechanistic science and dogmatic religion could coexisting in the same person. Mechanistic science deals with physical reality, whereas dogmatic religion deals with the meaning of life and the invisible aspects of reality. The alliance between mechanistic science and dogmatic religion soon took shape, and in order to guarantee the peaceful coexistence between science and religion, science had to remain within the boundaries of the mechanistic approach. Any attempt to go beyond mechanical causation was and still is fiercely stopped.

This dichotomy and alliance allowed for the industrial revolution, which would have been otherwise impossible.

After Newton the Church started supporting the mechanistic approach. Institutions such as the Pontificial Academy of Sciences hold membership rosters of the most respected names in science, including Nobel laureates. While supporting the mechanistic approach, these institutions severely censor any attempt to expand science beyond the cause and effect mechanistic vision.

3. Crisis of duality

Galilean relativity states that the fundamental laws of physics are the same in all inertial systems. Galileo used the example of a ship travelling at constant velocity, without rocking, on a smooth sea; any observer doing experiments below the deck would not be able to tell whether the ship is moving or stationary. The Galilean principle of relativity says that in inertial systems, i.e. systems that move in a uniform motion, the same laws of mechanics apply: no experiment conducted within a given inertial system can highlight the uniform motion of the system, and the laws of physics are always of the same form. Galileo understood that it is not possible to detect if a system is fixed or moves with uniform motion. This principle was formulated as follows:[12]

> *"Shut yourself up with some friend in the main cabin below decks on some large ship, and have with you there some flies, butterflies, and other small flying animals. Have a large bowl of water with some fish in it; hang up a bottle that empties drop by drop into a wide vessel beneath it. With the ship standing still, observe carefully how the little animals fly with equal speed to all sides of the cabin. The fish swim indifferently in all directions; the drops fall into the vessel beneath; and, in throwing something to your friend, you need throw it no more strongly in one direction than another, the distances being equal; jumping with your feet together, you pass equal spaces in every direction. When you have observed all these things carefully (though doubtless when the ship is standing still everything must happen in this way), have the ship proceed with any speed you like, so long as the motion is uniform and not fluctuating this way and that. You will discover not the least change in all the effects named, nor could you tell from any of them whether the ship was moving or standing still. In jumping, you will pass on the floor the same spaces as before, nor will you make larger jumps toward the stern than toward the prow even though the ship is moving quite rapidly, despite the fact that during the time that you are in the air the floor under you will be going in a direction opposite to your jump. In throwing something to your companion, you will need no more force to get it to him whether he is in the direction of the bow or the stern, with yourself situated opposite. The droplets will fall as before into the vessel beneath without dropping toward the stern, although while the drops are in the air the ship runs many spans. The fish in their water will swim toward the front of their bowl with no more effort than toward the back, and will go with equal ease to bait placed anywhere around the edges of the bowl. Finally the butterflies and flies will continue their flights indifferently toward every side, nor will it ever happen that they are concentrated toward the stern, as if tired out from keeping up with the course of the ship, from which they will have been separated during long intervals by keeping themselves in the air. And if smoke is made by burning some incense, it will be seen going up in the form of a little cloud, remaining still and moving no more toward one side than the other. The cause of all these correspondences of effects is the fact that the ship's motion is common to all the things contained in it, and to the air also. That is why I said you should be below decks; for if this took place above in the open air, which would not follow the course of the ship, more or less noticeable differences would be seen in some of the effects noted."*

[12] Galileo Galilei (1623), *Dialogue Concerning the Two Chief World Systems, Second Day*.

Galileo shows that for an observer, on an inertial system, it is impossible to conclude whether the system is moving or stationary. For an observer on another inertial system, for example on the sea shore and looking to the ship in motion, the speeds of bodies on the ship will add up to the speed of the ship. For example, if a ship is moving at 20 km/h:

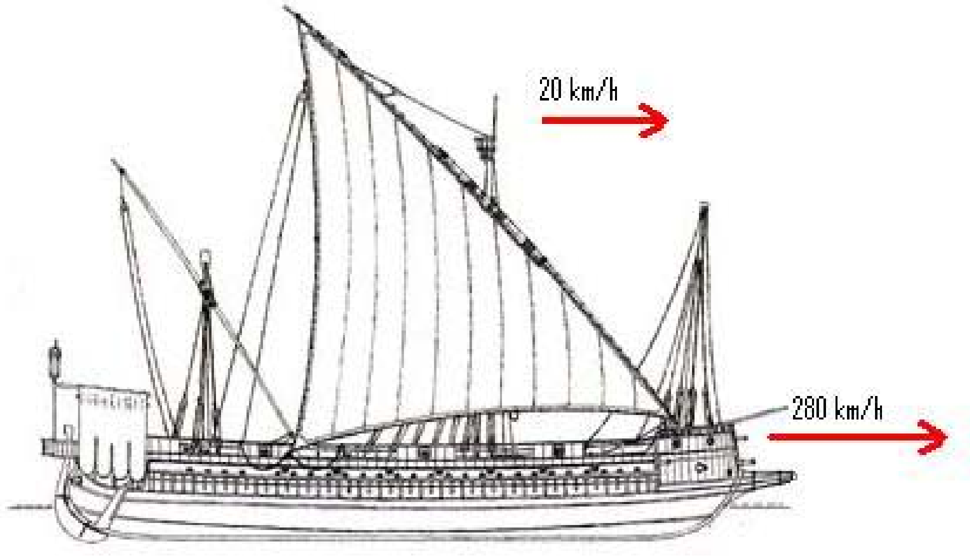

Figure 1 – Galileo's relativity allowed to generalize the mechanistic vision

and a cannon ball is fired at 280 km/h in the same direction to the movement of the ship, the observer on the sea shore will see the cannon ball move at 300 km/h, 280 km/h of the speed of the cannon ball plus 20 km/h of the speed of the boat. If the cannon ball were fired in the opposite direction to the movement of the ship the resulting speed would be 260 km/h, 280 km/h of the speed of the cannon ball minus 20 km/h of the speed of the boat (speeds are subtracted because they move in opposite directions). On the contrary for a sailor on the ship sharing the same movement of the ship, the cannon ball would always move at 280 km/h in any direction he would fire it. Therefore, if an observer on the seashore sees the cannon ball moving at 300 km/h and the boat in the same direction at 20 km/h he can conclude that the ball was fired at 280 km/h.

Galileo's relativity is based on the principle that when changing an inertial system, speeds are added or subtracted on the basis of their relative speeds. In Galileo's relativity, speeds are relative to the inertial system, while time flows in an absolute way for all the systems.

Galileo's relativity provided the way to generalize the laws of mechanics and classical physics is based on Galileo's relativity.

But, in 1886 two American physicists, Michelson and Morley, conducted experiments which show that Galileo's relativity does not apply when dealing with the speed of light. They found that the speed of light does not add up to the speed of the body which is emitting it.

Let us imagine now, after 500 years, an astronaut on a very fast space ship heading towards Earth at 20,000 km/s who shoots a laser light ray towards Earth (at 300,000 km/s). An observer on Earth will not see the laser light move at 320,000 km/s, as Galileo's relativity would predict, but it will see it move at 300,000 km/s (because the speed of light is a constant). According to Galileo's relativity, the observer on Earth would expect that the astronaut on the space ship would see the light ray move at 280,000 km/s (300,000 km/s of the speed of light minus 20,000 km/s of the space ship) but, on the contrary, also the astronaut on the space ship sees the laser ray move at 300,000 km/s.

In 1905, analyzing the results obtained by Michelson and Morley, Albert Einstein found himself forced to invert Galileo's relativity according to which time is absolute and speed is relative. In order to describe the fact that the speed of light is constant, it was necessary to accept that time is relative. In his Special Relativity Einstein proved mathematically that what varies is time. When we move in the direction of light our time slows, and for us light continues to move at the same speed. This leads to the conclusion that approaching the speed of light time would slow down and stop, and if we could move at speeds higher than the speed of light, time would reverse.

In other words, events which happen in the direction in which we are moving become faster, because time slows down, but events which happen in the direction from which we are coming become slower, because time becomes faster.

In order to explain this situation, Einstein liked to use the example of lightning which strikes a railway simultaneously in two different points, A and B, far away from each other.[13] An observer sitting on a bench half-way would see the lightning strike the two points simultaneously, but a second observer on a very fast train moving from A to B passing next to the first observer at the moment in which the lightning strikes the two points would have already experienced the lightning striking point B, but would have not experienced the lightning striking point A. Even if the two observers share the same point of space at the same moment, they cannot agree on the events which are happening in the direction in which the second observer is moving. Agreeing on the existence of contemporary events is therefore linked to the speed at which the observers are moving.

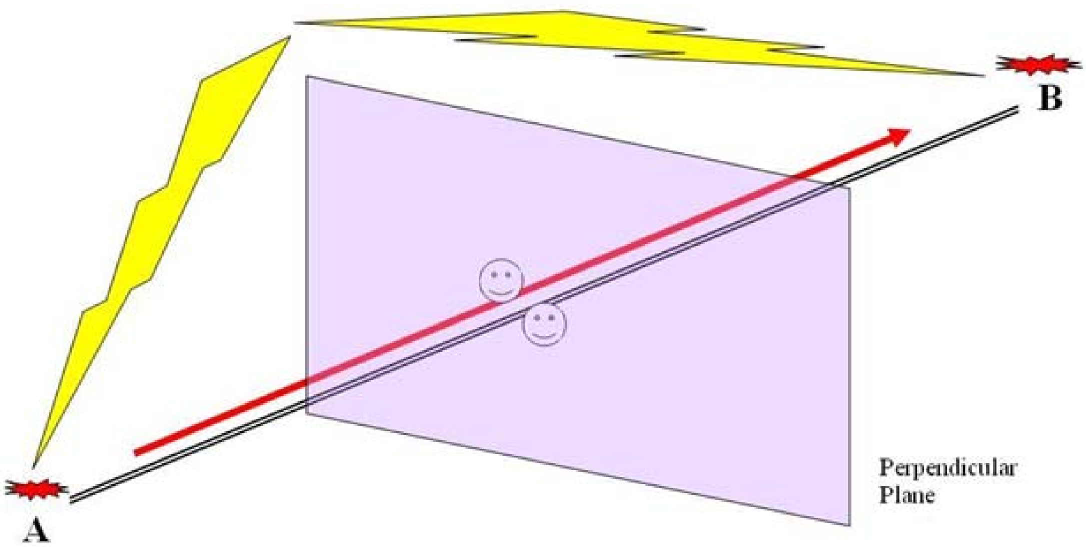

Figure 2 - Two observers who share the same point of space at the same moment, cannot agree on the events which are happening in the direction in which the second observer is moving.

[13] Einstein A. (1916) *Relatività, esposizione divulgativa,* Universale Bollati Boringhieri, Torino 1967.

Time flows differently if the event is happening in the direction towards which we are moving, or in the direction from which we are coming.

This example is limited to two observers; but what happens when we compare more than two observers moving in different directions at high speeds? The first couple (one on the bench and the other in the train) can reach an agreement only on the contemporary existence of events which happen on a plane perpendicular to the movement of the train. If we add a third observer moving in another direction, but sharing the same place and moment with the other two observers, they would agree only on events placed on a line which unites the two perpendicular planes; if we add a fourth observer, they would agree only on a point which unites the three perpendicular planes; if we add a fifth observer, who is not even sharing the same point in space, no agreement would be possible at all.

If we consider that only what happens in the same moment exists (Newton's time concept), we would be forced to conclude that reality does not exist. In order to re-establish an agreement between the different observers, and in this way the existence of reality, we need to accept the coexistence of events which could be future or past for us, but contemporary for another observer. Extending these considerations, we arrive at the necessary consequence that past, present and future coexist[14]. Einstein himself found it difficult to accept this consequence of special relativity since it is intuitive to imagine time which flows from the past to the future, but counterintuitive to imagine that past, present and future coexist! Einstein used the term *Übercausalität* (supercausality) to refer to this new model of causality. Yet, Einstein was well aware that extending the current scientific paradigm to supercausality would reopen the conflict between science and religion. He therefore found a stratagem which permitted to reduce the equations of Special Relativity to the $E = mc^2$ relation, which only deals with classical time.

Few people know that the mass-energy relation $E = mc^2$, which is usually attributed to Albert Einstein, had been published by several others before, including:

1. the Englishman Oliver Heaviside[15] in 1890 in his *Electromagnetic Theory* vol. 3;
2. the Frenchman Henri Poincaré[16] in 1900;
3. the Italian Olinto De Pretto in 1903 in the scientific journal "Atte" and registered at the "Regio Istituto di Scienze"[17].

In deriving this equation, Einstein's predecessors made assumptions that led to problems when dealing with different inertial systems, since the quantity of motion was not present in the equation. Einstein succeeded where others had failed by deriving the formula in a way that was consistent in all frames of reference. He did so in 1905 with his equation for Special Relativity, which adds momentum to the $E = mc^2$ equation:

$$E^2 = m^2c^4 + p^2c^2$$

where ***E*** is energy, ***m*** is mass, ***p*** momentum and ***c*** the constant of the speed of light

[14] Fantappiè L. (1955a) *Conferenze scelte,* Di Renzo Editore, Roma 1993.
[15] Auffray J.P., *Dual origin of E=mc2*:http://arxiv.org/pdf/physics/0608289.pdf
[16] Poincaré H,. *Arch. néerland. sci*. 2, 5, 252-278 (1900).
[17] De Pretto O., *Lettere ed Arti*, LXIII, II, 439-500 (1904), Reale Istituto Veneto di Scienze.

This equation is known as energy/momentum/mass. However, since it is quadratic, it has two solutions for energy: one positive and one negative.

The positive or forward-in-time solution describes energy that diverges from a cause, for example light diverging from a light bulb or heat spreading out from a heater. But in the negative solution, the energy diverges backward-in-time from a future cause; imagine beginning with diffuse light energy that concentrates into a light bulb. This, quite understandably, was considered an unacceptable solution since it implies retrocausality, which means that an effect occurs before its cause. Einstein solved this problem by assuming that the momentum is always equal to zero; he could do this because the speed of physical bodies is extremely small when compared to the speed of light. And so, in this way, Einstein's complex energy/momentum/mass equation simplified into the now famous $E = mc^2$ equation, which always has positive solution.

But in 1924 Wolfgang Pauli (Austrian physicist, Nobel Prize 1935) discovered that electrons have a spin which nears the speed of light. Soon after the Swedish physicists Oskar Klein and the German physicist Walter Gordon proposed the Klein-Gordon equation, in order to describe quantum particles in the framework of Einstein's relativity. This equation uses the full energy/momentum/mass equation of Special Relativity and yields two solutions: a forward-in-time wave solution (*retarded waves*) and a backward-in-time wave solution (*advanced waves*). But since the negative time solution was considered unacceptable, it too was rejected.

Werner Heisenberg (German physicist, Nobel Prize 1932) wrote to Wolfgang Pauli: "*I regard the backward-in-time solution ... as learned trash which no one can take seriously*"[18] and in 1926 Erwin Schrödinger (Austrian physicist, Nobel Prize 1933) removed Einstein's equation from the Klein-Gordon equation and suggested that time be treated in essentially the classical mechanical way, as only flowing forward.

Whereas the Klein-Gordon equation could explain the dual nature of matter (particle/wave), as a consequence of the dual causality (forward and backward-in-time causality), Schrödinger's equation was not able to explain the wave/particle nature of matter. Consequently, in 1927 Niels Bohr (Danish physicist, Nobel Prize 1922) and Werner Heisenberg met in Copenhagen and suggested an interpretation of quantum mechanics in which matter propagates as waves that collapse into particles when observed. This interpretation, in which the act of observation creates reality, implied the idea that men are endowed with God-like powers of creation and that consciousness precedes the formation of reality. But when Schrödinger discovered how Heisenberg and Bohr had used his equation, with ideological and political implications, he commented: "*I do not like it, and I am sorry I ever had anything to do with it.*"

In 1928 Paul Dirac (English theoretical physicist Nobel Prize in Physics for 1933 with Erwin Schrödinger) used the energy/momentum/mass equation in order to describe relativistic electrons. He was faced again with a dual solution: electrons (e^-) and neg-electrons (e^+, the anti-particle of the electron). Heisenberg's reaction was of outrage, since he perceived the backward-in-time solution as an abomination and in 1934 he replaced those parts of the equation which refer to negative energy, with an operator which creates unlimited numbers of "virtual" electron-positron pairs, without any energy input.

[18] Heisenberg W. (1928), *Letter to W. Pauli*, PC, May 3, 1928, 1: 443.

In 1934 Heisenberg took this escape window and, since then, physicists ignore the negative energy solutions of the two most used and respected equations in modern physics: the energy/momentum/mass equation of special relativity and Dirac's relativistic equation.

4. The dawn of non-dualistic science

The rejection of the negative energy solution has made the two theories upon which all modern physics rests, relativity and quantum mechanics, seem incompatible, since when they are combined together an unacceptable backward-in-time energy arises. Furthermore in the 1930s the scientific debate between special relativity and quantum mechanics was poisoned by political passions. In April 1933 Einstein learned that the new German government had passed a law excluding Jews from holding any official positions, including teaching at universities. A month later, the episode of the burning of books by the Nazis occurred, with Einstein's works being among those burnt, and Nazi's propaganda minister Joseph Goebbels proclaimed, "*Jewish intellectualism is dead*." Einstein's name was on a list of assassination targets, with a $5,000 bounty on his head and one German magazine included him in a list of enemies of the German regime with the phrase, "*not yet hanged.*" Einstein's treatises were burned, his suburban villa in Berlin was raided, and his furniture, books, bank account and even his violin were seized. Hitler's ideological convictions about Jewish science had received support from the book "*One hundred Authors against Einstein.*"[19] The theory of relativity was stigmatized as Jewish science, deliriums of a crazy Jew, whereas the Bohr and Heisenberg's Copenhagen interpretation was accepted.

Nevertheless several scientists were working on the idea of expanding causality beyond mechanical causation.

1. In 1941, while working on the d'Alembert operator, which combines special relativity with quantum mechanics, the mathematician Luigi Fantappiè[20] realized that the forward-in-time solution (i.e. *retarded waves*) describes energy and matter that diverge and tend towards a homogeneous and random distribution. For example, when heat radiates from a heater, it tends to spread out homogeneously in the environment; this is the law of entropy, which is also known as heat death. Fantappiè showed that the forward-in-time solution is governed by the law of entropy, whereas the backward-in-time solution (i.e. *advanced waves*) is governed by a symmetric law that Fantappiè named syntropy (from the Greek *syn* = converging, *tropos* = tendency). The forward-in-time solution describes energy that diverges from a cause, and requires that causes be in the past; the backward-in-time solution describes energy and matter that converge towards future causes (i.e. *attractors*). The mathematical properties of the law of syntropy are energy and matter concentration, an increase in differentiation and complexity, a reduction of entropy, the formation of structures, and an increase in order. These are also the main properties that biologists observe in life and which cannot be explained in the classical

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[19] Israel H., Ruckhaber E., and Weinmann R. (1931), *Hundert Autoren Gegen Einstein*, Voigtlander Verlag, Leipzig 1931.

[20] Luigi Fantappiè (1901-1956) was considered one of the foremost mathematicians of the last century. He graduated at the age of 21 from the most exclusive Italian university, "*La Normale Di Pisa,*" with a dissertation on pure mathematics and became a full professor at the age of 27. During the university years he was roommate with Enrico Fermi. He worked with Heisenberg, exchanged correspondence with Feynman, and in April 1950 he was invited by Oppenheimer to become a member of the exclusive Institute for Advanced Study in Princeton and work with Einstein.

(time forward) way. This realization led Fantappiè to formulate "*The Unitary Theory of the Physical and Biological World*", first published in 1942, where he suggests that we live in a supercausal universe, governed by causality and retrocausality, and that *life is caused by the future.*[21]

2. Similar considerations were reached by the paleontologist Teilhard de Chardin who pointed out the need for a law symmetrical to entropy: "*Reduced to its essence, the problem of life can be expressed as follows: once we admit the two major Laws of Energy Conservation and of Entropy (to which physics is limited), how can we add, without contradictions, a third universal law (which is expressed by biology) ... The situation is clarified when we consider at the basis of cosmology the existence of a second kind of entropy (or anti-entropy).*"[22] Teilhard de Chardin was a paleontologist and well-known evolutionary scientist and became famous after his death with the publication of his books, among which *The Phenomenon of Man* and *Towards Convergence*. Teilhard could not see traces of Darwin's evolutionary theory in paleontology, since the transition species are missing, and suggested a model of evolution which broadens science to a new type of causality which retro-acts from the future. For Teilhard life is guided by attractors which converge in the Omega point. Teilhard considered reality organized in three main concentric spheres. The innermost sphere is the final aim of the evolution of the universe, in which all of matter will be transformed into organic and conscious matter, and it is also the closest to the Omega point. The outer sphere is the most distant from the Omega point, the realm of inanimate matter. The middle sphere is the realm of life which does not yet reflect on itself, the biosphere. It is worthwhile noting the decree of the Holy Office in 1958, chaired by Cardinal Ottaviani, which imposed religious congregations to withdraw the works of Teilhard from all their libraries. The decree states that the texts of the Jesuit "*offend Catholic doctrine*" and alerted the clergy to "*defend the spirits, especially of the young, from the dangers of the works of father Teilhard de Chardin and his disciples*."

3. The hypothesis that a different type of causality is required, had been postulated also by Hans Driesch (1867-1941), a pioneer in experimental research in embryology. Driesch suggested the existence of final causes, which act in a top-down way (from global to analytical, from the future to the past) and not in a bottom-up way, as happens with classical causality. Final causes would lead living matter to develop and evolve, and would coincide with the purpose of nature, the biological potential. Final causes were named by Driesch entelechy[23]. Entelechy is a Greek word whose derivation (*en-telos*) means something that contains in itself its own end or purpose, and that evolves towards this end. So, if the path of normal development is interrupted, the system can achieve the same end in another way. Driesch believed that the development and behavior of living systems are governed by a hierarchy of entelechies, which all result in an ultimate entelechy. The demonstration of this phenomenon was provided by Driesch using sea urchin embryos. Dividing cells of the embryo of sea urchin after the first cell-division, he expected each cell to develop into the corresponding half of the animal for which it had been designed or preprogrammed, but instead he found that each developed into a complete sea urchin. This also happened at the four-cell stage: entire larvae ensued from each of the four cells, albeit smaller than usual. It is possible to remove large pieces from eggs, shuffle the blastomeres and interfere in many ways without affecting the resulting embryo. It appears that

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[21]Fantappiè L. (1942), *Sull'interpretazione dei potenziali anticipati della meccanica ondulatoria e su un principio di finalità che ne discende*, Rend. Acc. D'Italia, 1942, 4(7).
[22]Teilhard de Chardin P. (2008), *Il fenomeno umano.* Queriniana, Brescia, 2008.
[23]Driesch H. (1908), *The Science and Philosophy of the Organism*, www.gutenberg.org/ebooks/44388

any single monad in the original egg cell is capable of forming any part of the completed embryo. Conversely, when merging two young embryos, a single sea urchin results and not two sea urchins. These results show that sea urchins develop towards a single morphological end. The moment we act on an embryo the surviving cell continues to respond to the final cause that leads to the formation of structures. Although smaller, the structure which is reached is similar to that which would have been obtained by the original embryo. It follows that the final form is not caused by the past or by a program, a project or a design which act from the past, since any change we introduce in the past leads to the formation of the same structure. Even when a part of the system is removed or the normal development is disturbed, the final form is reached and it is always the same. Another example is that of the regeneration of tissues. Driesch studied the process by which organisms are able to replace or repair damaged structures. Plants have an amazing range of regenerative capabilities, and the same happens with animals. For example, if a flatworm is cut into pieces, each piece regenerates a complete worm. Many vertebrates have extraordinary capabilities of regeneration, for example, if the lens of the eye of a newt is surgically removed, a new lens is regenerated from the edge of the iris, whereas in the normal development of the embryo the lens is formed in a very different way, starting from the skin. Driesch used the concept of entelechy to account for the properties of integrity and directionality in the development and regeneration of bodies and living systems. Driesch argued that many of the basic problems of biology cannot be solved by a an approach in which the organism is simply considered a machine. Driesch works have been accused of implying metaphysical teleology and vitalism, and have been rejected.

4. Wilhelm Reich (1897-1957) was an Austrian psychoanalyst, and one of the most radical figures in the history of psychiatry. He was the author of several influential books and essays, most notably Character Analysis (1933), The Mass Psychology of Fascism (1933), and The Sexual Revolution (1936). His work on character contributed to the development of Anna Freud's The Ego and the Mechanisms of Defence (1936), and his idea of muscular armour. It was in New York in 1939 that Reich first stated he had discovered a life force, or cosmic energy. He said he had seen traces of it when he injected his mice with bions. In 1940 he began to build insulated Faraday cages that he believed would concentrate the orgone, and called them *orgone accumulators*. These accumulators were tested on mice with cancer, and on plant growth. Reich showed that orgone is able to destroy cancerous growth, since tumors in all parts of the body disappear or diminish. In 1956 Reich was sentenced to two years in prison, and in June and August of that same year over six tons of his publications were burned by order of the court. One of the most notable examples of censorship in the history of the United States. He died in jail of heart failure just days before he was due to apply for parole.

After the end of World War II, any finding which was extending science beyond mechanical causation was censored and fiercely suppressed. The aim of science was not any more seeking authentic knowledge and sharing the results with the community of knowledge seekers, but it had become a matter of power. Digressions from the mechanistic paradigm were no longer tolerated and were punished with fierce censorship, discredit and removal from the academic or research position. A new era in science24 took shape where profit-seekers, individuals scientists as well as institutions, became secretive, often inserting wrong information in their manuscripts, so that others

[24] Bauer H. (2012), *Dogmatism in Science and Medicine: How Dominant Theories Monopolize Research and Stifle the Search for Truth*, McFarland, 2012

could not benefit from the knowledge of crucial details of their work. 25 Sharing of information became a rarity26, and fraud and dishonesty the norm. The absolute necessity for uninterrupted flows of grant money brought enormous pressure to take on only projects that guarantee publications, on aggressively curate scientific journals. Luxury-scientific journal editors started building bubbles in fashionable fields, where researchers can make the bold claims these journals want, while discouraging other important works:

> "*I work in a psychiatric research group and the highest cited papers are in psychiatric genetics, where non-replication is the norm. These studies have only managed to account for a small proportion of the variance in severe mental illness. But, research into social risk factors (e.g. childhood adversity, migration, poverty), which are known to be important determinants of mental health, is rarely funded by the research councils, despite its obvious utility in promoting public mental health, and is never published in Nature, Science or any of the highest impact journals. There is a negative correlation between the usefulness of research and its likelihood of appearing in the top journals.*"[27]

But now, a widespread chorus of scientists is calling for a change towards a new way of doing research, which will comprise qualitative and quantitative, objective and subjective, and take into account the context and complexity.

5. Probabilities or possibilities?

The conflict between special relativity and quantum mechanics, which can be traced back to Einstein's sentence "*God does not play dice*" and to his rejection of the use of probability in physics, led Einstein to the conviction that a new mathematics is needed. Einstein was accused of hardline determinist, but Wolfgang Pauli showed that Einstein was not a determinist but a realist, with the belief that the deeper forms of causality, brought to light in relativity and quantum theory, can be understood only in terms of what Einstein named *Übercausalität*, supercausality, and that supercausality requires "*an entirely new kind of mathematical thinking.*"

The problem with mathematics is due to the fact that it has to be deterministic. For example, in order to guarantee determinism, functions are "injective", which means that to each value of x only one value of y can be associated. But, square roots (which are at the basis of supercausality) provide always two values for y, one positive and one negative.

[25] Hazen R.M. (1988), *The Breakthrough: The Race for the Superconductor*, Summit Books / Simon & Schuster.
[26] Mirowski P. (2011), Science-Mart: Privatizing American Science, Harvard University Press.
[27] www.theguardian.com/commentisfree/2013/dec/09/how-journals-nature-science-cell-damage-science

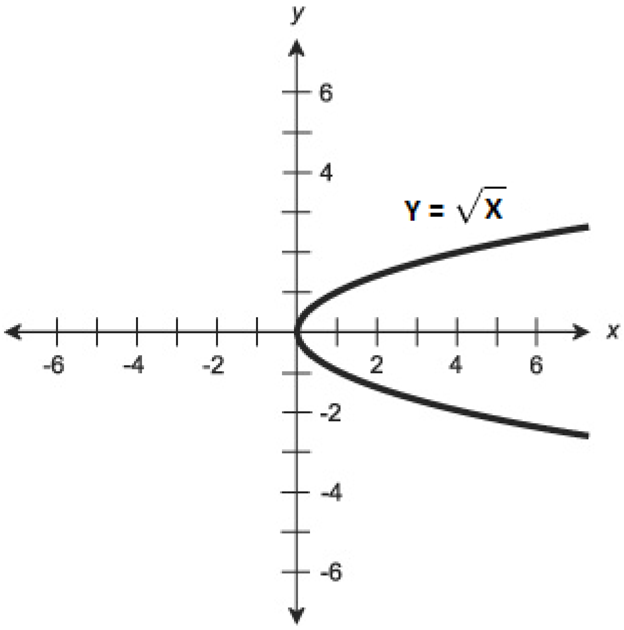

Fig. – Graphical plotting of square root values

For example, the square root of number 4 (*x* axis) results in the values 2 and -2 (*y* axis). This makes square roots non-deterministic and non-injective and creates a paradox within mathematics, since any *x* value is associated to two *y* values.

Mathematicians responded to this paradox in an arbitrarily way, considering only the positive values of square roots and pretending that the negative values do not exist, as it is shown in the following plotting of the square root function.

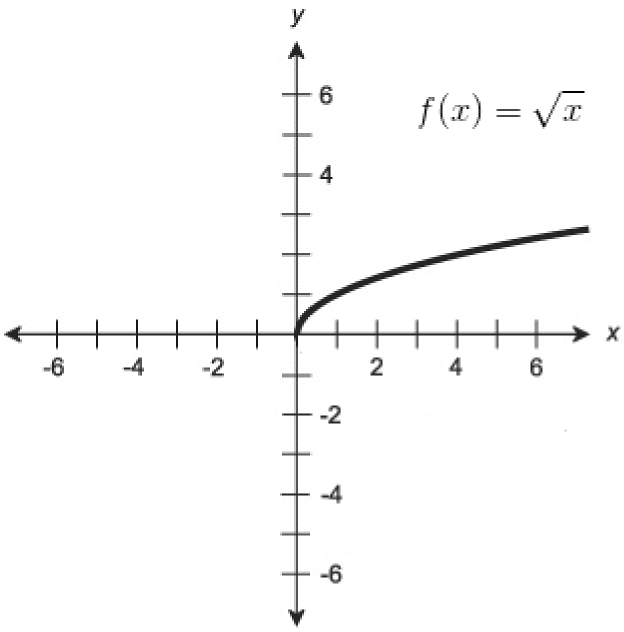

Fig. - Square root function. Negative values are arbitrarily omitted.

The idea that the "*book of nature*" is written in mathematical characters and that the aim of science is to find the exact functions which govern causality, proved wrong in population studies. Population studies have been taking place for thousands of years, with the first known census undertaken nearly 6000 years ago by the Babylonians in 3800 B.C.. Records show that Babylonians undertook censuses every 6 or 7 years, counting the number of people and livestock, as well as quantities of butter, honey, milk, wool and vegetables. The oldest existing census comes from China and took place during the Han Dynasty in the year 2 A.D.. Censuses were a key element of the Roman system of administration and were carried out every five years and provided a register of citizens and their property. The word census originates from the Latin word 'censere' which means 'estimate'. The Bible's Book of Numbers describes the counting of the Israelite population during the Flight from Egypt and of course the best known reference to a Roman census, is when the birth of Jesus occurred in Bethlehem and Mary and Joseph had to travel there to be enumerated. The most famous historic census in Europe is the Domesday Book which was undertaken by William the Conqueror in 1086. Population studied brought to the development of a different approach to numbers, which in the 18th century took the name of "statistics". Statistics was initially limited to the systematic collection of demographic and economic data, but it soon developed in the study of causality and it is now widely applied in experimental sciences and in the field of inference, which is the process of deriving logical conclusions from premises known or assumed to be true.

Statistics uses probabilities and this makes it non-deterministic and profoundly different from mathematics. On the other hand, statisticians generally feel an inferiority complex towards mathematicians and tend to compensate this feeling trying to turn statistics into a highly complex mathematics. An example is provided by logistic functions, which were developed in 1845 in the field of population forecast, by the mathematician and doctor in number theory Pierre François Verhulst. Verhulst was inspired by Thomas Malthus' book "*An Essay on the Principle of Population*",[28] first published in 1798. Malthus stated that every twenty-five years the population grows according to a geometrical ratio (1, 2, 4, 8, 16, 32, 64, 128, 256 ...), while the amount of food available grows according to an arithmetical ratio (1, 2, 3, 4, 5, 6, 7, 8, 9 ...); therefore, while the population doubles, food resources show a much more modest increase. Consequently, Malthus forecast was that in the year 2000 the proportion between population and food resources would be 4,096 to 13 and food resources would not be sufficient for the needs of the population. Malthus believed that, in order to stop this rapid growth of population, famine and disease were needed and were the two main instruments of population control. Hunger, epidemics, wars, but also the extermination of babies would contribute to control the population, thus balancing the population and the food. Logistic functions compare growth with available resources and essentially incarnate Malthus ideology. Even though they lead to systematically wrong results, they are extensively used in fields that range from artificial neural networks, biology, demography, economics, psychology, sociology and political science. Examples span from wrong demographic predictions, used to allocate resources, to wrong financial projections, used to guide investments (this was one of the major causes of the 2007 financial crisis), and wrong forecasts which have led whole economies in the slums.

People think of statistics as a kind of mathematics, but statistics and mathematics are used in different fields. Statistics is mainly used in life sciences, such as demography, economics, biology,

[28]Malthus T.R. (1798), *An Essay on the principle of population as it affects the future improvement of society*, Reprint, London: Reeves and Turner, 1878.

medicine, psychology and sociology, whereas mathematics is used in mechanistic sciences, such as engineering and physics. This difference suggests that statistics is linked to life, whereas mathematics is linked to non-life. This consideration has led the first statisticians to question the difference between organic and inorganic, in order to better understand the specificity of statistics and mathematics. An example was provided by the faculty of Statistics in Rome, where regular meetings were held in order to study the difference between organic and inorganic. Experts from the most diverse disciplines were invited to participate.

Nonetheless, a new approach is taking shape. This approach, first named cybernetics, is used in computer programming and involves loops that require feedbacks, which trigger choices. It is different from mathematics since it treats data in the binary (0/1) form and not in the quantitative form. Facts have proved that in this way, translating all the information in bit of information (which can only be 0 or 1) the highest complexity can be achieved, whereas using the quantitative approach only few very limited applications are possible. Similarly, in the field of statistics when translating all the information in the dichotomous form 0/1, the most complex analyses are possible. Qualitative and quantitative data, subjective and objective, and an unlimited number of variables can be handled together.

This new approach is based on choices. Choices between different possibilities. Choices can be deterministic, as it usually happens with computer programs, or non-deterministic as it happens with statistics. In both cases, the key concept is that we live in a realm of possibilities which are not governed by linear functions or logistic equations, but by a complex interaction between the system and the context.

6. The decline of science

In 1989, the American National Academies of Science (NAS) published a booklet entitled *On Being a Scientist,* in 1995 it added the sub-title *A Guide to Responsible Conduct in Research*. In the same period, the National Institutes of Health (NIH) established an Office of Research Integrity[29], which all too often reports penalties enacted on researchers who have been found dishonest. On the first of October 2012, The Guardian published the article "*Tenfold increase in scientific research papers retracted for fraud. Study of 2,047 papers on PubMed finds that two-thirds of retracted papers were down to scientific misconduct, not error.*"[30] A study, published on the Proceedings of the National Academy of Sciences (PNAS)[31], found that papers are retracted mainly because of fraud. In the 5 October 2012 editorial of the New York Times "*Fraud in the scientific literature*"[32] it is suggested that researchers are competing for inadequate available resources[33] and have become grant-seekers, who continuously need to publish. This situation is leading researchers towards deliberate fraud and dishonesty, which is now considered to be endemic within science.[34,35]

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[29] http://ori.hhs.gov/
[30] www.theguardian.com/science/2012/oct/01/tenfold-increase-science-paper-retracted-fraud
[31] www.pnas.org/content/109/42/17028
[32] www.nytimes.com/2012/10/06/opinion/fraud-in-the-scientific-literature.html?_r=0
[33] Freeland Judson H. (2004), *The Great Betrayal: Fraud In Science*; Etchells P. and Gage S. (2012), *Scientific fraud is rife: it's time to stand up for good science. The way we fund and publish science encourages fraud*, The Guardian, 2 November 2012.
[34] Broad W. and Wade N. (1982), *Betrayers of the Truth: Fraud and Deceit in the Halls of Science*, Simon & Schuster, 1982.

Publish or perish is a phrase coined to describe the pressure to rapidly and continuously publish scientific works. Frequent publication is one of few methods at disposal to demonstrate scientific talent. Successful publications bring attention and sponsoring institutions, and facilitate funding. Scientists who publish infrequently, or who focus on activities that do not result in publications, find themselves out of the funding tracks. It is now widely recognized that the pressure to publish is one of the main causes of poor research and fraud in science.

Scientific fraud is usually perpetrated at the moment of data analysis, using complex mathematical models which allow for easy manipulation and fraud. When data-analysis becomes complex a state of confusion is triggered, partly because of the complexity of the techniques, and mainly because there is a clear-cut distinction between statistics and mathematics which is being violated. Statistics uses numbers in an intuitive and obvious way, it is based on good sense and simple mathematics, and it is not limited to the enumeration of reality, since it extends to the study of causal relations.

Causal relations are mainly investigated using Galileo's experimental method which provides a path that, starting from similar groups, introduces a treatment and attributes the differences (effects) to the treatment (cause). This methodology is based on the study of differences and has limited science to the exploration of cause and effect relations. Since differences can be manipulated by keeping or removing outliers[36], results can be easily object to fraud.

Fortunately another path in the study of causality is provided by the methodology of concomitant variations which instead of differences among groups, searches for concomitances among dichotomous variables. This methodology can handle an unlimited number of qualitative and quantitative variables, uses simple mathematics, can keep track of the context and of the complexity of natural phenomena, leads to results which are robust and usually easy to replicate and does not allow for fraud.

[35]Bauer H. (2014), *The Science Bubble*, EdgeScience #17, February 2014, http://www.scientificexploration.org/edgescience/

[36]In statistics, an outlier is an observation that is distant from other observations. An outlier may be due to variability in the measurement or it may indicate experimental error. Consequently, it is commonly accepted that researchers can freely include or exclude outliers from the data set, changing in this way the outcome of the results.

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