



# The Turbulent Sea of Virtual Particles...and the Transdisciplinary Vision

**Simona Modreanu<sup>1</sup>, Alina Gavrilut<sup>2</sup>, Gabriel Crumpe<sup>3</sup>, Maricel Agop<sup>4</sup>**

<sup>1</sup>Department of French language and literature, Alexandru Ioan Cuza University, Iasi, Romania, Email: simona.modreanu@gmail.com

<sup>2</sup>Department of Mathematics, Alexandru Ioan Cuza University, Iasi, Romania

<sup>3</sup>Department of Physics at Gh. Asachi Technical University, Iași, Romania

<sup>4</sup>Faculty of Psychology of Alexandru Ioan Cuza University in Iasi, Romania.

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**F**rom the Hindu Vedas and the ancient Greek philosophy to the modern transdisciplinary vision and complex thought are solid proofs that the identification of the truly indivisible, ultimate particle. Science has reached nowadays the frontiers of metaphysics, and quantum physics, the levels of reality, the fractals, the holographic universe, the standard model of cosmology, etc. cause human beings to ask themselves again the questions that science cannot answer: *Where do we come from? Who are we? Where are we going?*

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*Stolzius (...) was a searchlight in the void, and we were the void.*

(I.P. Culianu)

## 1 Brief historical overview

Having fallen from Paradise into time, man seems to carry two essential nostalgias that are, in effect complementary: the nostalgia for being reintegrated in the One, and that, more humanly unsettling, for identifying the smallest seed of creation. It is between searching the bigger infinity and the smaller infinity that our entire destiny as creatures runs its course, at once dramatic in the acknowledgment of our ontological and gnoseological limitations, and exalting in the richness and diversity of forms of existence and comprehension. The breaking of the original oneness pulverised our relation to reality into fragments of elements, teachings, experiences, but our yearning for the ultimate meaning drives us towards the global, holistic comprehension. Therefore, one formula that summarizes such a totalising intellectual endeavour would be:

*cognition - knowledge - (re) cognition*

Since Paradise was not satisfactory, and he decided to shake the forbidden tree, man went on to sharpen his curiosity and restlessness on every threshold he encountered, on every obstacle that would not allow him to look “beyond”. Upwards, we hit the issue of the universe’s finitude or infinitude; meanwhile we found out that the most remote object (theoretically) observable emitted its light in the first moments of the transparent universe, approximately 13.7 billion years ago, thus defining what we call the “visible horizon”; we cannot see and implicitly know anything beyond this distance. We do not know whether the universe stretches any further or not. We do not even know whether this question makes sense.

Downwards, the issue of the smaller universe also concerns the identification of the truly indivisible particle. Experimentally, however, things are so complicated and costly (as was the case of the discovery of the Higgs boson), that many physicists, mainly quantum mechanics specialists, have abandoned the search for the fundamental particle after reaching the conclusion that there are no independent entities, as they are all interconnected. Others have taken novel directions that are no less plausible, especially when they tend to confirm the second Hermetic principle, that of correspondence - “As above so below: as below, so above.” - in other words, the principle of the holographic universe, in which every part contains the whole and is contained within it. For instance, professor Andy Parker from Cambridge University has shown (and his opinion is shared widely by NASA physicists) that the singularity at the core of a black hole could easily run for the title of the smallest part of the universe, since, according to some of the current formulation of the laws of physics, black holes form when matter is condensed in a space so small that it becomes an infinitesimal point. In Eminescu’s words: “Suddenly, a dot starts moving - the primeval, lonely Other...” (Levitchi). The search for the infinitesimal “dot” of space is also in the realm of the smaller infinity. But as the issue of space continuity or discontinuity has not been resolved yet, we may wonder whether the minuscule “Planck length” truly is the spatial *quantum*, or whether it is merely a length beyond which none of the current physics theories apply. No-one knows...

## 1.1 From the Indian to the Greek atom

A very brief, inevitably incomplete and subjective diachronic excursion will take us back to *atomism* as a thought pattern, not just as a particular philosophical and scientific vision of the ancient Greeks, but also as a perspective that constantly questions the transition from discontinuity to continuity, from small to large, from multiple to unit, issues that stand as landmarks across the entire history and philosophy of sciences.

Let us return for a moment to the Indian *Vedas*, and particularly to the *Rigveda*, the oldest of the Vedic texts (dating, probably, from the 15<sup>th</sup> century BC), which is viewed as the source of the source of the Indian outlook on reality, and order in nature, the generally accepted origin of the Indian thought in physics and mathematics. The Vedic scholars started from the recognition of an indissoluble unity between all the constituents of this universe. This model of the interdependence between entities is also reflected in the approach of the structure of the cosmos, of language, but also on the place and role of the observer and of the object of observation, an issue that has been given a privileged treatment in the classical Indian physics thought. Almost 4000 years later, this has once again become part of the main discourse in physics and psychology when it comes to the dichotomic issues of order and disorder.

But maybe the most fascinating part of the *Vedas* are the *Upanishads*, India’s Brahman philosophical and spiritual texts. “The world proceeds from the void space”; “The void space was produced by the Supreme Being”, states the *Chandogya Upanishad*. And it seems that the entire discussion about parts and whole, about fractals and holism, about subject and object, about creation and destruction, about One and multiplicity, about void and so much more is contained by these few lines of the *Svetasvatara Upanishad* regarding the Brahman and the Purusha (the latter designating the Universal Being, the awakened Brahman, the Cosmic Principle, as well as Man, the self, the consciousness). Without going into nuances that are difficult to express in any language that inevitably distinguishes, separates, freezes as it were, let us say, for the sake of simplification, that the Brahman is the unimaginable creator, while Purusha is the imaginable creation. Only that the unimaginable God enters creation, enters a human being (“the Son of God”), who is merely a part of creation. This part of creation, filled with God, is called Purusha.

However, as part of creation, Purusha is also creation itself. A *fractal* of Brahman, if we may call it that:

1.8. The Lord, Isa, supports all this which is a combination of the perishable and the imperishable, the manifest, [...] and the unmanifest [...]. The same Lord, the Supreme Self, devoid of Lordship, becomes bound because of assuming the attitude of the enjoyer. The jiva by realizing the Supreme Self is freed from all fetters.

1.9. The Supreme Lord appears as Isvara, omniscient and omnipotent and as the jiva, of limited knowledge and power, both unborn. But this does not deny the phenomenal universe; for there exists further the unborn prakriti, which creates the ideas of the enjoyer, enjoyment and the object. Atman is infinite and all - pervading and therefore devoid of agency. When the seeker knows all these three to be Brahman, he is freed from his fetters.

1.12. The enjoyer (jiva), the objects of enjoyment and the Ruler (Isvara) - the triad described by the knowers of Brahman – all this is nothing but Brahman. This Brahman alone, which abides eternally within the self, should be known. Beyond It, truly, there is nothing else to be known.

Before leaving this fascinating meditation, here is a fortunate comment made by Swami Tejomayananda to one of the sections of the same *Svetasvatara Upanishad*, to help us better understand the complexity of Indian thought, so succinctly formulated:

III.9. The whole universe is filled by the Purusha, to whom there is nothing superior, from whom there is nothing different, than whom there is nothing either smaller or greater; who stands alone, motionless as a tree, established in His own glory.

God/Truth has no cause or effect. The cause always exists before the effect. It means that nothing exists before the effect. In means that nothing exists before God. This is accepted by all the religions of world. However Vedanta also says that God/Truth is not the cause of anything. He is not the Creator! Nothing really comes from him, since nothing is different from him. God/Truth is neither a cause of anything nor an effect from anything. Nothing exists before Him or after Him, He is one without a second. The non-dual God/Truth alone exists. From the absolute standpoint God/Truth is not the Creator of the world.

There is nothing greater or smaller than God/Truth. [...] God/Truth is beyond all concepts of small or great, all is Him alone. Even at the relative plane, God/Truth is subtler than space which exists in the smallest atom and also engulfs the whole universe.

(Tejomayananda: 122-124)

This is food for thought and for many books in the above, but we shall not dwell, but instead continue this dynamic overview, leaping over a few centuries, although we shall inevitably return to this point.

In modern times, John Dalton, an English chemist and physicist in the late 18<sup>th</sup> century, was credited with the development of atomic theory. Mankind seems to have a short attention span and be possessed of presumptuous ignorance. In fact, a first (?) theory regarding atoms was formulated approximately 2500 years before Dalton by an Indian scholar, Kashyap, also known as Acharaya Kanad, born in 600 BCE. Legend has it that Kashyap was on a pilgrimage to Prayag when he saw thousands of people filling the streets with flowers and grains of rice as offerings to the temple. Fascinated by the tiny particles, he started picking up the grains. When the curious crowd asked him why he was collecting grain that even a beggar would reject, he replied by saying that individual grains may appear to lack value in themselves, but that together, a few hundred grains could provide a meal to one person, and many more than that could feed the entire world. Therefore, a single grain of rice is the same as important as all the wealth in the world. People called the rice grain *kan*, which in Sanskrit means “the smallest article”, and Kashyap became known as Kanad, that is “the master of the smallest things”.

In fact, Kanad began taking an interest in the invisible and conceptualised the principle of the smallest particle, which he called indivisible matter, *parmanu*, or *anu*. Etymology comes, as always, to the rescue: In Sanskrit, *anu* means “minuscule”, “atom”, “subtle”, “minute unit of time or space”. As for the word *atom*, used universally, it comes from Greek and it consists of a privative prefix, *a-*, and the verb *a-temnein* “to cut”, designating thus a thing that cannot be cut, separated into fragments. Acharya Kanad stated that this indivisible matter cannot be perceived by any human sensory organ, it cannot be seen with the naked eye, and that an inherent force has determined one *anu* to combine with another, resulting in a combined substance, a *dwinuka* (binary molecule), the various combinations of *anu* producing various types of substances; he also stated that breaking *anu* apart would result in *maha-anu* (nucleus). Kanad also said

that *anu* may have two different states: absolute stillness and movement, postulating thus the existence of 108 particles - 108 being the divine number for the Hindus, since Vedic science asserts that our universe consists of 108 elements. 108 is also the number of Upanishads.

This is particularly interesting, given that the founder of the Periodic Table of the Elements, Dmitry Mendeleev, openly expressed his gratitude to Indian scholars, especially to the famous Panini, who gave him the rules for organizing the grammar of his elements, 63 at the time Mendeleev designed the table, but 108 in most of the tables used today, where the elements listed after hassium, the 108<sup>th</sup> and the heaviest element in the periodic table, have only a laboratory existence, where they live for about a thousandth of a second. To make the connection even more striking, Mendeleev had also anticipated the atomic mass of this element, hassium, which he called *eka-osmium*, *eka* meaning “one”, “the first”, “the only”, “the sole”, in Sanskrit, but used by Mendeleev with the very transdisciplinary meaning of “beyond”. In other words, One beyond the apparent multiplicity.

Returning to Kanad, let us add that he founded Vaiśeṣika (a Sanskrit word meaning “special”, “excellent”), one of the six “orthodox” Hindu philosophical schools, where he taught the comprehension of the atom and of the nature of the universe, and where he wrote the *Vaiśeṣika Sūtras*, becoming known as “the father of atomic theory.” Surprisingly, he also considered the mind to be an eternal and indivisible atom, the fifth, after the four fundamental constituents, the atoms of air, fire, earth and water. Very close to Vaiśeṣika was the Nyaya school (the name meaning “rules”, “method”, “model”, “axiom”, “judgment”), led by the philosopher Praśastapada, known especially for the development of the theory of logic in her epistemology works. Nyaya-Vaiśeṣika goes far beyond a mere presentation of atomism, it evokes the properties of matter and offers an entire metaphysics, associated with logic, arguing, for example, that the imperceptibility of the atom is explained metaphysically: atoms are eternal substances and prime causes. Therefore, in brief, the two schools have given us two possible directions for approaching the atom:

1. physics (the atom being considered a material constituent / a constituent of matter)
2. metaphysics (through the eternal atom *nitya*)

In Indian physics, matter is reduced to an abstract *anu* that emerges as four fundamental types of matter due to the four types of fundamental movements of this atom / *anu*. The atom is an energy point with zero mass and dimensions. This view is comparable to the point of view of modern physics, for which elementary particles such as electrons, protons, bosons, etc. are mere clouds of energy that enter into various combinations to form the whole of known matter. The beginning of the creation process is characterized by the motion acquired by the atom together with certain inherent properties, and that is the point where time begins. Kanad reduces all matter, space, and time to certain functions of “motion”. In the absence of movement, even time falls to zero. The observer represented by the mind is also a function of movement. The whole universe is only matter and observant mind that are capable of motion. Indian physics is an observer-centred system, with space-time as the fundamental matrix through which the entire universe is observed by the observer. It considers that time collapses in the period of stillness between creation and cosmic disintegration, time being a function of the “state of motion” of the cosmos, which “rests” in this period between creations and dissolutions. Matter is preserved in the atomic state.

Space is also eternal and continues to remain as it is. The *anu* of Indian physics is an atom insofar as it is still indivisible and a-causal or indestructible. But the difference is that the Kanad the philosopher does not attempt to describe only visible matter, but instead proposes a complete system of space, time, matter, in order to describe the entire cosmos that begins with the visible matter and extends to categories and potentials that are not similar to matter. His atom does not exist in real time. In its fundamental form, it possesses no motion, as motion is by definition visible.

It is not without interest to mention that neither Kanad nor Praśastapada explicitly raises the issue of the indivisibility of atoms, which results naturally from the other characteristics of atoms, especially from their eternity. And this is because, in Indian thought, eternity is synonymous with *causa prima*, the supreme principle, One, the indivisible substance.

*Nyayasūtra* speaks of the presence of the whole in each of the parts (2.1.32), opposing the Buddhist conception, considering that the whole is different from the sum of the parts. Therefore, a problem that

logicians and scientists still face today also kept the ancient Indians on their toes. However, they appeared to be sure of the answer. They had identified two categories of properties: properties of the whole that are not also properties of any of its parts, and properties of the whole those that are of the whole only because they are also properties of each of the parts. In other words, the contemporary discussion about *emergency* and *reduction*. What cannot be reduced to the properties of the component parts represents the emergence, the property of the whole. Nevertheless, there are controversies on this topic, the classical Indian philosophy is not homogeneous: according to Buddhists and Vedantists, for example, it is natural for us to think that the atom must also have parts, because it is penetrated outside and inside by the *akasha*. This notion, which has undergone many translations and interpretations over time, is fundamental and inescapable. Here are just a few defining elements of it in *Vaiśeṣika Sūtra*:

Akasa (ether), time and space have no lower constituents. (VS 2.1.27, 29-31)

Of akasa the qualities are - sound, number, dimension, separate-ness, conjunction and disjunction. (VS 7.1.22)

Thus, then, being endowed with qualities, and not being located in anything else, it is regarded as a substance.

And in as much as it has no cause, either homogeneous or heterogeneous, it is eternal. (VS 2.1.18)

And here we meet again with contemporary physics. Today, it is considered that vacuum is a cosmic medium that carries waves of photons and waves of density and pressure and that it is this vacuum that endows the particles with “mass”. This medium is not an abstract, theoretical entity, but instead has a full physical reality. The vacuum is “the holographic mechanism of information that records the historical experience of matter,” writes Ervin Laszlo, taking on the assertion of Edgar Mitchell (whose experience as an astronaut confirmed some of his theoretical assumptions, especially the idea that information and energy are parts of the same dyad, active information and effective being present everywhere in the universe, since the beginning of time) and bringing it closer to the Vedic *akasha*, this all-encompassing environment that underlies everything that exists and becomes everything. It is real, but it is so subtle that it cannot be perceived until it becomes all the things that populate the manifested world. Like an eternal library, the *akasha* (which means “cosmic sky, space” in Sanskrit) appears in the Upanishads as what sustains and carries creation from pure consciousness to physical form. *Akasha* shapes all manifestations, names them, contains them, reveals them, preserves their informational imprint. It is the original field from which emerge the elementary particles, the atoms, a dynamic environment, full of constantly fluctuating energy.

And visions meet and complement each other again, thousands of years apart, because, as Fritjof Capra points out, both modern physics and ancient Chinese philosophy consider change and transformation to be the primary aspect of nature, and regard the structures and symmetries generated by change as something secondary. In both systems, the focus is on the process rather than on things. The main coordinates of this Eastern conception, as a whole, are the unity and intercorrelation of phenomena, as well as the essentially dynamic nature of the Universe.

Buddhism came with a slightly different view from the Vedic one, closer to Taoism, through the concept of *vacuity*, which establishes the fundamental principle of interdependence. Nothing intrinsic exists, things, phenomena are empty in themselves and derive their nature from mutual dependence, the chain of connections being thus endless. Eastern spiritualities in general had an understanding of the vacuum that was very different from the Western one. For Buddhists and Taoists, *the vacuum is full*. Two thousand and five hundred years ago, Lao Tzu had already intuited that the vacuum had been the origin of all things. Similarly, the Buddhist teachers of the School of Mind, developed in 7<sup>th</sup> century China, would put their mind through the vacuum in order to purify it.

Master Yangshan asked Master Weishan, “What is the abode of the true Buddha?” Weishan answered, “by practicing reflective illumination on the boundlessness of the divine spark, through the profundity by which the absence of thought is arrived at through thought itself, conceptions are exhausted and one returns to the source. Eternally abiding in the essential nature, action and practice are not two, and this is the genuine ‘thusness’ of the true Buddha.”

([http://www.koreanbuddhism.net/bbs/board.php?bo\\_table=0020&wr\\_id=57&page=4](http://www.koreanbuddhism.net/bbs/board.php?bo_table=0020&wr_id=57&page=4))

Yang-shan’s question was about the abiding place of the true Buddha. In reply, Kuei-shan said. “By the ineffable subtlety of thinking without thinking, turn your attention inwards to reflect on the infinite power of the divine spark. When your thinking can go no farther, it returns to its source, where nature and form eternally

abide, where phenomenon and noumenon are not dual but one. It is there that abides the Suchness of the true Buddha.”

(<https://terebess.hu/zen/guishan.html>)

The “Suchness/Thatness”, that is *Tat Tvam asi*, is the famous formula of Vedantic Hinduism – “You are that”, the summarisation of the essential identity between One and the multiple forms of the real world.

The meditation of the Vaiśeṣika-Nyaya schools of thought continued with a natural question: how do we know that atoms exist, if they are imperceptible? Kanad and Praśastapada say, however, that we have several types of proofs in this respect:

1. logical and physical evidence (common practice): the decomposition of larger things exists in everyday life, and decomposition involves the atom;
2. ontological proof: in order to stop the regression *ad infinitum*, the decomposition process must have a limit.

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Leaving aside the Hindu space for the moment, let us turn our attention to the West, where *atomism* emerged in the 5<sup>th</sup> century BCE, its main representatives being the Greeks Leucippus, Democritus, Epicurus and Lucretius. It is difficult to say precisely whether and to what extent Indian culture influenced the Greeks, or vice versa, or whether these directions developed independently, being organically part of the expectation horizon of the era, which was one of the most prolific in the history of mankind, given that in the 6<sup>th</sup> and 5<sup>th</sup> centuries BCE millions of lives and perspectives were influenced, among others, by Heraclitus, Pythagoras, Socrates, Buddha, Lao-Tzi, Sun Tzu, Confucius, Zoroaster... Truly, a golden age!

But even Democritus does not seem to have been considered a pioneer in terms of ideas about the atom, this honour being given, in the ancient world of the West and the Near East, to a Phoenician named Mochus of Sidon, about whom who, unfortunately, we do not know a great deal; some researchers place him in the 13<sup>th</sup> century BCE, before the Trojan Wars. It is certain however that this proto-philosopher is mentioned in the writings of many ancient authors, such as Diogenes Laertius, Strabo, Flavius Josephus, Eusebius of Caesarea, and seems to have enjoyed a great reputation among scholars in the ancient world for his theory. He is believed to have established a school in Beirut, which operated until the 6<sup>th</sup> century BCE. Isaac Newton himself credited him as the author of the first atomic theory. But before Newton, Pythagoras was initiated into the ancient mysteries of the Phoenicians and studied for about three years in the temples of present-day Lebanon, specifically in Tire, Sidon, and Byblos. Unfortunately, nothing of Mochus’ original writings has been preserved, only their influence on his descendants.

All Atomists agree with the basic theory: the world is made up of atoms and *vacuum* (another major concept, which had to cross millennia before it managed to explain many of today’s perplexities!). Of the themes and concepts developed by Indian philosophers, atoms, the infinity of worlds, atheism, *ataxia* (peace of mind), the microcosm and the multiplicity of existences can be found in Democritus. According to some testimonies, Democritus met Indian philosophers during his travels. But on closer inspection, we see that the Indian philosopher Kanad proposed an atomic conception of matter based on nine types of atoms, while Democritus asserts an infinite number of categories exists. Therefore it is not at all certain that Greek atomism has its origin in Indian atomism, it may have been developed independently to answer the paradoxes of the Eleatics and the problems posed by Anaxagoras’ theory of the infinite divisibility of matter (see Lucretius, *Book I*). In fact, there were different schools in Greece as well, the vision of the composition of the world and the cosmos varying from one thinker to another, some struggling to avoid the thorny issue of vacuum, of nothingness.

Thus, Thales, around 600 BCE, strongly denied its existence, because nothing can arise out of nothing and cannot turn into nothing. But Thales wondered what was left if we took everything out of a given volume. His answer was in line with his own beliefs about the structure of the world: in that volume will remain a primordial element, namely water. Later, in the fifth century BCE, another great Greek thinker, Empedocles, sought to see whether air could be the substance that fills that empty space, and he

broadened the notion of primordial matter to four elements: air, water, fire and earth. But something else is more interesting to note in Thales' theory, from the perspective we have adopted here. He considered that matter has a granular structure, being made up by "packing" tiny spheres. Obviously, there is a free space between them that needs to be filled with something. That something was not, even for him, the vacuum, but a subtle form of matter, the *ether*, which was lighter than air.

Other philosophers insist on other aspects: Heraclitus, for instance, insists on the perpetual change in nature (as in classical Chinese thought); Parmenides argues that the whole Being is complete, continuous and permanent (as in the Vedic tradition). However, they all claim the existence of a hidden law that ensures the order of the world beyond appearances. And in fact, precisely the search for a more adequate description of the world is the one that underlies the atomistic models.

As a result of the numerous reflections developed by the predecessors of those mentioned above, Greek atomism was born in Abdera around the year 430, with the teachings of Leucippus. We know almost nothing about this philosopher from north-eastern Greece, but he remains forever famous for his idea of describing the universe in terms of vacuum and small microscopic, indivisible and unalterable Parmenidian worlds - *atoms*.

Leucippus was certainly familiar with the reasoning of Zeno and Melissos, and especially with the contradictions imposed by the continuous / discontinuous duality. The atomistic theory he founded was intended to solve the problems of emergence (form) and becoming. He also had to find compelling arguments in order to connect the concepts of time and space. For this purpose, Leucippus introduced a surprisingly modern symmetry of logical type to one of the qualities of Being: non-Being, their respective attributes being the Full and the Void. One remains unique, but, due to the existence of the Void, it can divide into a multitude of fragments with infinitely varied forms. Time is introduced by placing these "atoms", invisible and indivisible due to their small size, into a perpetual motion.

Also at that time, another thinker, Diogenes of Apollonia, was trying to return to the monism of his predecessors and thus came to develop a central idea for atomistic thinking, namely that all things are variations on the same theme:

2. (B2) In my opinion, to sum it all up, all things that are are differentiated forms of the same thing and *are* the same thing. And this is manifest. For if the things that are now in this kosmos - earth, water, air, fire, and all the rest that are seen to exist in this kosmos - if any one of these were different from another, being different in its own nature, [...] they could not mix with each other in any way nor could help or harm come to one from another [...]. But all these things, being differentiated out of the same thing, come to be different things at different times and return into the same thing.

Here is the whole unfolding of universal creation, with *Noûs* generating movement, life, multiplication, before becoming *Noûs* again. By using the notion of vacuum, atomists came to explain both identity and difference. Unfortunately, the traditions that took over and perpetuated their thinking often focused on minor, or even erroneous, issues. The reputation of the Greek atomists, untarnished for centuries, was based on the materialist models transmitted by Lucretius' text, *De Rerum Natura*. All things in nature have a cause and a necessity, Democritus believed, and therefore accident, randomness, chance are foreign to the Greek spirit, which considers them to be essentially anti-scientific. Both Leucippus and Democritus claim that there is a Law (*λόγος*) that governs the embodiment of material forms, but that this law can only be the result of a "principle of construction" rather than the revelation of a pre-existing form that would have intrinsic autonomy and a life of its own.

Probably a student of Leucippus, Democritus was undoubtedly familiar with the philosophies of his contemporaries and, in particular, with the reasoning of the Eleatic school. Therefore, he developed a system of nature in which he tried to resolve the duality of opposition between permanence and change, between continuous and discontinuous, and explained the progressive appearance of forms through infinite combinations of elementary atoms (of the four elements), moving by virtue of the principle of inertia. But necessity requires certain paths, certain interactions, which means that, despite the infinite variety of forms, they are never accidental.

Cognition of the world comes from the fact that we ourselves are composed of atoms and therefore able to interact with atoms moving in a vacuum. The image proposed by Democritus is particularly vivid and

strong, although far from specialized scientific terminology: he says that light is made up of smooth atoms that, entering our eyes, hit those who constitute us, thus provoking reactions and determining our intimate knowledge of the world. Consequently, the role of the senses is essential in the organization of knowledge. This uniqueness of the nature of things allows us to have access to reality.

From the perspective of atomists, the world has not had a beginning and will not have an end, and on the other hand there is no indication that just one world exists. Movement is a primordial principle of the Universe, it appears automatically, out of pure “necessity”. Of course, vacuum is a necessary condition for movement to occur. According to Diogenes Laertius, Leucippus imagined the creation of the world thus:

Leucippus’ opinion is this: All things are unlimited and they all turn around one another; the all [the universe] is both the empty [void] and the full. The worlds come to be when the atoms fall into the void and are entangled with one another. The nature of the stars comes to be from their motion, and from their increase [in entanglements]. The sun is carried around in a larger circle around the moon; and whirled around the center, the earth rides steady; its shape is drumlike. He was the first to make the atoms first principles.

(Diogenes Laertius, Lives of the Philosophers 9.30; tpc)

(67A1) He declares the universe to be infinite... Of this, some is full and some is empty [void], and he declares these [full and void] to be elements. An infinite number of kosmoi arise out of these and perish into these. The kosmoi come into being in the following way. Many bodies of all sorts of shapes, being cut off from the infinite, move into a great void. They collect together and form a single vortex. In it they strike against one another and move around in all different ways, and they separate apart, like to like. When they are no longer able to rotate in equilibrium, the fine ones depart into the void outside as if sifted. The rest remain together, become entangled, move together in unison, and form a first spherical complex.

A cosmic fresco of extraordinary force, in which the constancy of the themes that have preoccupied the human mind of all times is striking, because we find them in almost identical form in today’s physics and cosmology. Would we be able - even as science fiction writers - to sketch such an adequate projection of the world over 2500 years? But atomists not only have a rich and structured imagination at the same time, they are also the initiators of a consideration of causality, and the introduction of motion as a primordial given is a prelude to the reflection that Newton will make much later in *Principia Mathematica*.

This first idea, associated with that of vacuum, allows the shaping of a generative materialism in which the essential cause is the “necessity” of a motion that would cause the encounter of innumerable atoms and, through innumerable trials and errors, constitute forms, of which only the most stable will survive. We note the absence of the famous problem of “potentialities” that haunted Aristotle and permeated the entire Middle Ages. For atomists, forms are created by encounters, and their potentiality results from the plausibility of the encounter. Everything that has been achieved was possible, but what has not yet been achieved is a potential only insofar as the meeting *will occur* in a *predictable* time and place. It is important to remember that the world is traversed only once: no cause, no force was needed in order to impose the initial motion on the atoms, because their motion is eternal, past and future. Thus, the atomists rediscovered the ionic principle of the unlimited as an initial element, and this determined them to accept movement as a primordial principle.

Last but not least, atomists are also known for their advanced theory of animal or human sensations, which proposes a very modern view, unifying the description of the nature of things by including the particular properties associated with the human knowledge of the world. Atoms are the relays between objects and humans. For Democritus, seeing means receiving a reflection of what is being viewed. The underlying idea is that sight requires physical contact between the viewer and something emanating from the object being viewed. The same thing happens with other senses: certain atoms of the object are emitted, which enter through “pores”, whose shape is adapted to the nature of the object for the perceiver. Therefore our sensation and adequacy to the object are produced through the selection, mediated by said pores, of the specific components of the nature of the object.

Unfortunately, very few traces remain from the writings of that period, but even so, it is enough to realize that, through the fruitfulness and soundness of their thinking, the atomists of ancient Greece allowed the development of debates and research on topics that are still at the heart of our knowledge and queries today. The despotic omnipotence of finalist dualistic thinking has long denied them any justification, and



has certainly delayed many conceptual revolutions. By hundreds or maybe thousands of years. But some landmarks are there to show us how their thinking has been transmitted and enriched.

No need for microscopes or particle accelerators. Zeno's aporia was enough: dividing any amount of matter (or space, or time) into increasingly smaller quantities, if it knows no limits, can only lead to nothing. But matter is obviously not nothing. It is visible, it is heavy, it takes up space. QED: ultimately, it is made up of tiny entities that cannot be broken, connected to each other by "hooks" that are more or less strong... and separated by a vacuum. Today, we say that every particle of matter is actually condensed energy. But the ancient atoms of Democritus are in perfect agreement with the convincing definitions and experiences of modern science. However, before their timid reappearance, in the physics and chemistry of the nineteenth century, they were in a shadow cone for two millennia. Thus, from the seventeenth century to the end of the nineteenth century, successive editions of academic dictionaries demoted the atom to the rank of an archaic fantasy of Democritus and Epicurus, who argued that bodies are formed by the chance encounter of atoms. Academies granted them at most a metaphorical significance, but their fate was still better than that of Indian atomism, completely ignored by Europeans until the nineteenth century and, in fact, almost as ignored today.

Nevertheless, it is very difficult, without a deep and long meditation, to penetrate this rigor of atomistic thinking, this mysterious third included, about which transdisciplinarity speaks, this third path between chance (which, moreover, is not a notion suitable to the Greek spirit) and purpose, to admit that there can be a constant and purposeless force that directs the construction or development of the world. It is what atomists have called Necessity. But here Aristotle stumbled. The Stagyrte could accept things only in the light of their purposes. He did not conceive of the blind necessity of the vortex motion of atoms, without cause and without origin. Therefore, he cannot conceive of the existence of a vacuum, in which motion would not relate to any landmark, and atoms, without meeting the resistance of the environment, would reach infinite speeds. Since this is not possible, Aristotle concludes that no movement can take place in the *vacuum*. A concept he dismisses as useless, depriving the West, for nearly 2500 years, of the integration into science of this "turbulent sea of virtual particles", as Leonard Susskind calls it (2006:74).

It is true, however, that Aristotle also introduces, in addition to the four existing elements - insufficient for the description of the cosmos -, a fifth, the noblest, the element heavens are made of, a special element (quintessence - the fifth essence, the fifth being), weightless and unchanging, called *ether*, an element that, having gone through countless avatars throughout history (we have already met him as *akasha*), came to be - in a delayed ironical twist - to be identified with the vacuum!

Vacuum is related to *zero*, whose invention was a huge revolution in mathematics. Zero was born in India and not in the West, because it had very special properties that made the Greeks nervous. When you add zero to a number, that number remains the same. In addition, zero is related to infinity. When you divide a number by zero, you get infinity. When you divide a number by infinity, you get zero. The Greeks hated infinity! Not all of them, as we have seen, but as it happens, only those who had an overwhelming influence on the development of the Western world. They feared that these two dangerous and difficult-to-define notions - vacuum and zero - could result social chaos and panic among the population! Each era with its fears. For almost the same reason, for example, most records of the existence of extraterrestrial life and its interaction with our world are silenced. The foundation is the same: confronting the unknown, something that seems to elude the intellectual routine and existential patterns can lead us astray. Despite the dominant theories and ideology, we are too little equipped to accept otherness, difference, exception.

What is certain is that both Plato and Aristotle rejected the idea of discontinuous matter. For them, matter was, on the contrary, continuous and made up of different combinations of the four elements - water, air, earth and fire. In the West, the Church embraced this conception and did not let it go until the end of the second millennium. Like nature, the Church abhorred a vacuum, but also the "inferiority" implied by the atomistic hypothesis: if God had created matter out of nothing, that matter could no longer contain nothingness. But the Church did not just miss out on the vacuum. Above all, it hated to offend Aristotle and his finalism, which had provided such a convenient ready-made hierarchy of living beings that the Church only had to place under the tutelage of the Creator. So it took it all, wholesale.

Finally, the atomist theory had to contend with the dogma of the Eucharist: how can one say that the Christic bread and wine are made up of atoms and vacuum? What then happens to their transubstantiation, as a result of which they become the true body and true blood of Christ, without changing their appearance? Based on unpublished documents, Pietro Redondi, an Italian historian, states that Galileo's heresy was not the one we know from the history books and that the real reason for his condemnation lies in his declared adherence to the atomist theory and, not coincidentally, in his rejection of Aristotle's theory of falling bodies. The Jesuits did not necessarily reject his assertion that the Earth is the one that revolves around the Sun, but instead his conviction that it is made up of "substantial atoms". This was a much more... modern sin. Doubting the structure of matter was tantamount to attacking dogmas, especially that of transubstantiation. Faced with the Reformation, the Catholic Church had just uncompromisingly reaffirmed this dogma, one of the main sources of discord with the Protestants. It was not at all the right time for the situation to be complicated by those ridiculous stories about the atoms. Or by debating them publicly during a trial. Consequently, Galileo was discredited under another pretext - the theory of the Earth revolving around the Sun, an idea which, incidentally, the defendant had not even invented, but instead borrowed from Copernicus. Despite all these obstacles, atomic theory ended up triumphing and providing resounding proof of its reality. Today, listed and classified, atoms are no longer all considered indivisible, but no one doubts that they constitute the totality of observable matter.

## 1.2 About vacuum and ether in the Middle Ages and beyond

The legacy of ancient Greece and the influence of Aristotle were the protégés of the Church, practically unshakable during the Middle Ages, the relationship between part and whole, between transformation and immutability being arguments to the liking of the clergy. Here is how they are formulated, in his *Confessions*, by Saint Augustine:

[...] being assured "That Thou wert, and wert infinite, and yet not diffused in space, finite or infinite; and that Thou truly art Who art the same ever, in no part nor motion varying. [...]"

(Book VII)

Thomas Aquinas and other theologians and philosophers would argue, until the dawn of Renaissance, that "God is whole in all beings and in each." (1997: 117) And the vein of alchemy did not seek to prove otherwise. The transmutation of metals, the elixir of eternal life, or the restoration of the original purity of soul sought only the same restoration of lost unity, of the resettlement of matter and spirit in their primordial matrix. The unifying principle in the *athanor* is the salt between oppositions: cold and hot; male and female; fixed and volatile. Carl Gustav Jung, the famous Swiss scientist, spoke about the essential duality that characterizes alchemy. From its inception, it combined the *Gnostic spirit* of Greek natural philosophy with the highly developed *techno-magic*, so to speak, of ancient Egypt. His examples refer to old metallurgy and to the embalming process associated with the regeneration of Osiris. Jung's fundamental idea is that Western alchemy developed as a kind of underground current complementary or compensatory to the Christian conflict of body/soul, good/evil opposites. Alchemy would thus be a search for God's divine spark in the darkness of the world below. In the solution/dissolution stage of the Black Work, the external and internal impurities are dissolved, in the congelation step of the White Work, the dichotomies disappear as antagonisms and turn into the energy of a dynamic system of contradictions (about which Ștefan Lupășcu spoke) that makes possible the leap to the level of the Red Work, that of melting into one, a moment where the alchemist can no longer tell whether he is the subject or the object of the process, becoming himself the Work, the philosopher's stone. A transrational reality that shatters the principle of identity and Aristotelian logic.

After the Renaissance, the modern world and science began to be built on different foundations, meaning that science no longer depended on metaphysical considerations and dogmatic interests, but instead on experiments such as those of Torricelli, a student of Galileo, the first to create a vacuum in a tube, or on those of Pascal. Coming from such a comprehensive and flexible ancient view of the universe, especially

in Indian philosophy, one cannot help but be astonished by the truncations and fragmentation imposed on freedom of thought by an increasingly reductionist and despotic control of the Church, which was, unfortunately, one of the historical instigators of the separation between science and religion, of the fracture of integrative knowledge. It is enough to watch the struggle of a genius like Pascal, who tried his best to reconcile his authentic faith (the famous “Pascal’s wager” is, in fact, the expression of a profound confusion) with the spirit of the experimental scientist, which pushed him to take Toricelli’s research further, thus contributing enormously to the development of geometry and mathematical analysis, and of the probability theory. He also spoke at length about the small infinity and the great infinity, equally inaccessible to direct sight and knowledge, which must be supplanted by the dimension of the imaginary, and returned to the ancient visual metaphor of the infinite sphere, which many erroneously attribute to him:

But if our view be arrested there, let our imagination pass beyond; it will sooner exhaust the power of conception than nature that of supplying material for conception. The whole visible world is only an imperceptible atom in the ample bosom of nature. No idea approaches it. We may enlarge our conceptions beyond all imaginable space; we only produce atoms in comparison with the reality of things.

(...) It is an infinite sphere, the centre of which is everywhere, the circumference nowhere.[30] In short it is the greatest sensible mark of the almighty power of God, that imagination loses itself in that thought.

(...) I will let him see therein a new abyss. I will paint for him not only the visible universe, but all that he can conceive of nature’s immensity in the womb of this abridged atom. Let him see therein an infinity of universes, each of which has its firmament, its planets, its earth, in the same proportion as in the visible world.

(For all the English quotes from Pascal:

<https://www.gutenberg.org/files/18269/18269-h/18269-h.htm>)

Still, under the religious mark and influence of the era, but also of the rationalism and anthropocentrism that were beginning to take root in the collective mind, Pascal could not overcome the fracture between the two already established fundamental types of knowledge, he could not, spiritually, to admit the fertility of the idea of vacuum, assimilating it with the sterile nothingness (“Infinite - nothing - Our soul is cast into a body, where it finds number, time, dimension.”), although, in order to accept its experimental existence, he stood up to Descartes. The inability to “weld” together the two horizons caused Pascal to struggle in this ontological ambiguity, as in his view man was a being that belongs to an interval - nothing in relation to infinity and everything in relation to nothingness - but infinitely distant from both poles. Unfortunately, the median position is not made positive either, it is not an *aurea mediocritas* in the vein of the ancient Chinese thought, or of Aristotle or Horace, namely an area of reconciliation of opposites through their wise fusion, but one of fragile and unstable balance:

70. [Nature has set us so well in the centre, that if we change one side of the balance, we change the other also. I act. Τά ζῶα τρέχει This makes me believe that the springs in our brain are so adjusted that he who touches one touches also its contrary.]

Around the same time, Sir Isaac Newton, the creator of classical mechanics, published his work *Philosophiae Naturalis Principia Mathematica*, which would become a revolution in physics, and not only. Let us note that although Newton and Leibniz are credited with discovering the most powerful mathematical tool - differential and integral calculus with infinite series, virtually all of Newton’s work on physics and infinitesimal analysis has borrowed the theory and results of the mathematicians and astronomers of the Kerala school in south-western India, who had been familiar with them since the 1400’s (such as the Gregory series, or the sine and cosine functions). These discoveries seem to be come from a single genius scientist, Madhava, as gifted as his compatriot Ramanujan, the excellence of the Indians in mathematics and computer science being well-known. Moreover, it appears that the law of gravity was also known to Indian scholars since ancient times. In *Surya Siddhanta*, a traditional treatise on astronomy dating from 400-500, Bhaskaracharya notes:

The Earth has an attractive power by which it draws itself and heavy objects in the air... This attractive power of the Earth shows why things located at a lower part, or at the sides, do not fall from its surface... Objects fall

on earth due to a force of attraction by the earth. Therefore, the earth, planets, constellations, moon, and sun are held in orbit due to this attraction.

About 1200 years later, Sir Isaac Newton (re) discovered this phenomenon and stepped through the main door of physics with the law of gravity tied to his name. The information was probably brought to the West by Jesuit missionaries. However, Newton remains one of the very few people who has managed to fundamentally change his peers' way of thinking, sparking a revolution that expanded far beyond the boundaries of physics. But the theory that dominated physics for more than two centuries had a flaw. In his exciting *Book of Nothing*, John Barrow writes:

Despite the power and simplicity of Newton's ideas, there was an awkward assumption at their heart. Newton had to suppose that there existed something that he called 'absolute space', a sort of fixed background stage in the Universe upon which all the observed motions that his laws governed were played out.

The movement of all the bodies in the Universe had to relate to this "absolute space" which, in turn, is in a state of absolute rest. It could not be observed directly or acted upon, so "it began to sound as mysterious and elusive as the vacuum itself" "begins to sound as mysterious and elusive as the vacuum itself" (Ibid.). We know, however, that in the wake of Aristotle, the idea of empty space was difficult to accept, and then an idea gradually gained ground: that the space between objects in this world was not empty, but instead filled with a kind of immobile fluid, which came to be called *ether* (Chapter 3 will resume and develop the topic from the perspective of physics). Newton, John Barrow tells us, was not overly enthusiastic about this substance, he would have liked something more rigorous for his theory, although he acknowledged that this ether could be a convenient vehicle for understanding some of the properties of light and its propagation through space. Newton was a follower of the corpuscular theory of light, he saw it as a sum of very small particles (photons, as we call them today), problems arising when light behaved like a wave. But let us take another leap over time.

For the light wave, it is precisely this ether that should be the propagation medium. An ether with special features, which scientists tried to explain and verify experimentally in the centuries that followed. It is a fascinating search, concluded with the experiments of Michelson and Morley (1881 and 1887), who wanted to directly prove the existence of the ether. Both experiments failed. The ether, widely accepted by the physicists of the time, showed little sign of existence. Nevertheless, all this led to Albert Einstein's 1905 great revolution.

So, in modern times, ether is dead, gone from the scientific lexicon. The voice of Greek Antiquity seems to resound defiantly again: emptiness is nothing, zero does not exist... All good until Paul Dirac, the English physicist, stated (in 1928) that the vacuum is full, with infinite negative energy even. In his equations (as in everything quantum physics), energy is always associated with time, but the minus sign appears in front of positrons. It took the nonconformist scientist Richard Feynman for the idea that positive energy can be associated with negative time to emerge. In other words, in what he called *reversed time*, the positrons move back in time, carrying with them the information of the present. For now, time travel is only possible at this subatomic level...

### 1.3 Quantum physics and - again - the Vedas

Quantum physics, as we know, explains the nature and behaviour of matter and energy at atomic and subatomic level. The term *quantum mechanics* itself was coined in the early 1920's by a group of physicists at the University of Göttingen, three giant minds, all three Nobel Prize winners: Werner Heisenberg, Niels Bohr and Erwin Schrödinger, who were also united by one, perhaps surprising, passion. All three were avid readers of the *Vedas*; moreover, we could say that they elaborated upon these ancient books of wisdom in their own language, with modern mathematical formulas, in an attempt to understand those complex concepts that ancient Sanskrit called "Brahman", "Paramatma", "Akasha", "Atman", "Anu". In 1925, the worldview of physics materialized in a model of the universe as a large machine made up of particles of matter that can interact separately. Over the next few years, Schrödinger, Bohr, Heisenberg and their followers outlined a universe based on inseparable waves with superimposed amplitudes of probability.

Of the three, Schrödinger was probably the most imbued by this perception of the universe, which he considered “some blood transfusion from the East to the West to save Western science from spiritual anaemia” (My View of the World). His understanding went so far that when Heisenberg argued that quantum mechanics broke down the barrier between Cartesian notions of *Res cogitans* and *Res extensa*, Schrödinger replied that the wording of the problem must be completely overturned, because talking about the collapse of the separation between the subject and object is absurd, since there has never been such a separation. The subject and the object are one in the primordial experience, and the Vedic doctrine of identity expresses this unity very well. In fact, he says, quantum mechanics did not break down a pre-existing barrier between subject and object, but restored an initial state of fact, in which the mechanisms of objectivation do not work.

“This life of yours which you are living is not merely a piece of this entire existence, but in a certain sense the whole,” Schrödinger concludes from the texts of the Vedic tradition, fascinated by the amazing summarising force of the Brahmins sacred formula, so simple and so clear: *tat tvam asi*, you are that. No less comprehensive appears to him the formula “I am in the east and the west, I am above and below, I am this entire world”, better known later on in its Hermetic version, the foundation of alchemy and the essence of the fractal universe, “As above, so below”, the whole is in the part and the part is in the whole. This also explains the “butterfly effect” theorised by Lorenz, because, since the universe is a whole, information is intrinsically non-local and will be instantaneously transmitted across arbitrarily long distances, which means that an action occurring in a single place can instantaneously influence an action at the other end of the universe.

Talking about a universe in which particles are represented by wave functions, Schrödinger opined that “The unity and continuity of Vedanta are reflected in the unity and continuity of wave mechanics. [...] This new view would be entirely consistent with the Vedantic concept of All in One”. It is also in the *Upanishads* that the physicist finds the confirmation of the idea that multiplicity is only apparent. And not just there, in fact. All the mystical experiences of union with God lead to this idea. Ancestral Indian wisdom was as clear as it could be about determinism and free will, stating that there is no framework in which to find *consciousness* in the plural; we construct this inflection because of the temporal plurality of individuals, but it is a false construction - a truth that we often forget ... All events occur in the universal, unique consciousness, and there is no plurality of self; the self or its separation from the absolute Self is an illusion (how well Fabre d’Olivet understood this, he who translated “Elohim” by the extraordinary singular-plural phrase “He-the-gods”, in the *Cosmogony of Moses*, too little known, because... non-canonical!).

The unity of consciousness was unequivocally expressed by the Austrian physicist at the end of one of his lectures, when he stated that “Atman is equal to Brahman”, adding that this is “Schrödinger’s second equation”. Recognizing this identity is not considered blasphemous in Indian thought, on the contrary, it is the ultimate goal of our earthly destiny, the sudden comprehension and assimilation of the boldest possible thought. Imagine how most Christian prelates today would react if you went to confession and said, “I am God.”! Only the mystical, esoteric vein has kept alive this ultimate truth which, paradoxically, took quantum physics to have us reminded of it. The most subtle science as a revealer of spiritual and material unity – this is the lesson of the search for the ultimate particle!

There are many traces and influences of Vedic philosophy in Schrödinger’s physics, but let us just say that, from the above, another notion arises that interests us here, namely *holism*. In his early reflection on quantum physics, Schrödinger takes a view that particles and atoms should not be perceived as small bodies isolated from each other, but as modes of vibration of a single background, which he will later equate with the universe as a whole.

Niels Bohr was himself an avid reader of the *Vedas*: “I go into the *Upanishads* to ask questions”, he used to say each time he hit a roadblock with some theory or experiment, after having found, like Schrödinger before him, that their experiments in quantum physics concurred with what they had read in the ancient Indian sacred books.

In the 1920’s, Werner Heisenberg formulated his famous uncertainty principle, which states that when one tries to observe a subatomic particle, the experimental device inevitably changes its trajectory. This is because it attempts to observe something that has the same scale as the photons used to observe it. In

other words, to observe something of subatomic dimensions, it is necessary to use a device that projects photons on the observed particle, and the reception of photons by our retina is what we call sight. The problem is that photons disrupt subatomic particles because they are the same size. Consequently, there is no way to observe subatomic particles without changing their trajectories. But the interaction between subject and object is discussed at length in the texts of ancient Indian philosophy. In fact, Heisenberg was convinced that “Quantum theory will not look ridiculous to people who have read Vedanta.”

In his turn, Fritjof Capra, interviewed by Renée Weber for the volume *The Holographic Paradigm*, spoke thus about Schrödinger’s account of Heisenberg:

I had several discussions with Heisenberg. I lived in England then [circa 1972], and I visited him several times in Munich and showed him the whole manuscript chapter by chapter.

He was very interested. [...] He said that he was well aware of these parallels. While he was working on quantum theory he went to India to lecture and was a guest of Tagore. He talked a lot with Tagore about Indian philosophy. Heisenberg told me that these talks had helped him a lot with his work in physics, because they showed him that all these new ideas in quantum physics were in fact not all that crazy. He realized there was, in fact, a whole culture that subscribed to very similar ideas. Heisenberg said that this was a great help for him. Niels Bohr had a similar experience when he went to China.

But, as expected, this revolution of thought, of vision of the world and the universe, did not win everyone’s favour. In 1935, Albert Einstein, Boris Podolsky and Nathan Rosen challenged quantum mechanics and especially what we know as the Copenhagen Interpretation, in other words, the impossibility of determining the state of a system before a measurement that practically forces the system to collapse the wave function, that is to choose to update only one of the multiple virtual possibilities. The mental experiment of “Schrödinger’s cat” is a graphic illustration of this theory. But Einstein, a strong follower of quantum determinism, could never accept quantum indeterminacy and the concept of *instantaneous causal influence at a distance*, creating his own paradox (EPR) and challenging Bohr until the end of his life. Even without detailing all these physics theses (this is better left to the specialists), it is interesting to note how the highest expression of classical physics, reached and surpassed in the theory of relativity by Einstein’s genius, struggles with a fracture of vision introduced by quantum mechanics, which seriously shakes paradigms and notions that we thought were definitive landmarks in explaining the world, introducing an additional number of metaphysical implications, which modern and contemporary science was not ready to accept. To a large extent, it is not prepared today either, although transdisciplinarity and its major concepts, especially that of “level of reality”, greatly facilitate a comprehensive understanding.

It has been said that Albert Einstein also read the *Bhagavad-Gita*, and that after this reading, meditating on how God created the world, everything else appeared superfluous to him. It is, however, unlikely if we look at the constants of his outlook. What is certain is that physicists have not yet finished checking whether Bohr or Einstein were right and, above all, how to reconcile the two visions. But these contradictory debates and perspectives have at least the merit of opening a door to another possible reading of the world, although, no matter how many experiments we do, we can never reach the absolute truth by using inevitably imperfect tools of perception.

Schrödinger had no direct knowledge of Sanskrit, but other important scientists, attracted by this complex thinking, such as Robert Oppenheimer, had learned Sanskrit. He read the *Upanishads* and the *Bhagavad-Gita* in the original, referring to them as some of the most decisive influences in shaping his own philosophy. Significantly, after taking part in the first nuclear test in 1945, he instantly quoted *Bhagavad-gita* chapter 11, text 32: “I am mighty Time, the source of destruction that comes forth to annihilate the worlds”...

In any case, many decisive books written by personalities such as Thoreau, Kant, Schopenhauer, Schrödinger, Heisenberg, Tesla, Einstein, etc., who came into contact with Vedic texts, convey, in one form or another, the idea that reality - first and last - remains timeless and unchanging.

The inventor Nikola Tesla, one of the most spectacular and prolific spirits of all time, is perhaps the most mysterious example of the assimilation of Brahman knowledge, which led him to mathematical formulas of unique subtlety. It is not known how Nikola Tesla came into the area of influence of the *Vedas*, much of his life and work being erased from history, for this brilliant man, with 125 patented inventions, with

knowledge of 12 languages (including Sanskrit, whose construction grammar fascinated him) and holder of 14 doctorates in universities around the world, was not able to monetise his ideas and discoveries, going instead - from a financial point of view - from one failure to another. Tesla invented many things that we use every day, although most people have only heard of this name in the form of the American company, run, it is true, by another visionary genius, Elon Musk. But Nikola Tesla understood the great power of the Zero Point (synonymous with *akasha* or *ether*), being the first contemporary scientist to openly express the idea that space vacuum is not empty. Tesla used the old Sanskrit terminology, which was very familiar to him, in order to describe the universe as a kinetic system full of energy, to which man could connect anywhere and at any time. After numerous conversations with the great thinker Swami Vivekananda and after studying in depth study the Vedic texts, the Croatian engineer deciphered the mechanisms that govern the world in Hindu philosophy, assimilating mainly the concepts of *akasha* (ether) and *prana* (the source of universal energy), and adhering to the concept of *luminiferous ether* in order to describe the source, existence and structure of matter (the light effect was demonstrated by Georges Sagnac in 1913), the ether being synonymous with electricity, from his point of view. He explained all observable phenomena through this “infinitesimal world, made up of molecules and their atoms carrying static charges, rotating around their own axis and moving along their orbits, like celestial bodies, engaging the ether in their movement...” (Conference at Columbia College, 1891).

However, in the struggle with Einstein’s theory of relativity, Tesla’s luminiferous ether lost, being since mentioned at best in discreet, almost embarrassed footnotes. Few victories in modern physics have been so total. Today, relativity gives us the best picture we can have of the macrostructure of the universe. But it cannot be generalized, and the inability to explain the behaviour of the universe at the smallest scales, where only the laws of quantum physics work, clearly indicates that a unitary, integrative, holistic fundamental theory is absolutely necessary.

And, as a culmination of universal irony, the key to the “salvation” of relativity might lie precisely in the much-maligned and ignored ether. Since the early 2000’s, a group of researchers have argued that this invisible substance, full of space, could have the power to unite physics, to help build a theory of everything. More and more scientists adhere to this viewpoint. Recently, two independent groups of astrophysicists have suggested that the resemblance between ether and the dark force that populates our cosmos cannot be a mere coincidence (Figure 1). For some, ether is synonymous with dark matter. For others, it could explain dark energy. And the most daring consider that he could designate both...



**Figure 1:** *Courtesy of ESO*

It is difficult to touch upon the ether issue without opening up the vacuum issue. This seems to be the key word for understanding the organization of the small and the big infinity. Vacuum possesses its

own energy. Nothing, in the sense of absolute void, exists, as long as quantum mechanics postulates - and experiments confirm - the existence of an energy. The vacuum is fluctuating, filled by energy and the movement of billions of particle-antiparticle pairs, which are generated and disappear permanently. On the other hand, particles also contain a quantum vacuum, in a significant proportion. The atom, for example, is much larger than the electrons and nucleus that make it up. Protons in turn contain quantum vacuum, as their mass is largely the movement of quarks rather than the actual sum of the masses of quarks. Almost 90% of the mass of protons comes from the moving energy of quarks, and only 10% from the actual mass of these small constituents (Wilczek, 2003: 32). Even fundamental interactions can be seen as forms of vacuum, argues John Barrow.

Therefore we are entitled to ask: after all, what is an atom made of? We all learned in school that an atom contains a nucleus at its centre and electrons orbiting the nucleus. The nucleus contains nucleons, that is protons and neutrons. However, our knowledge of atoms is very recent, and it was not until the end of the 19<sup>th</sup> century that scientists began to study it in detail. We now know that, despite the etymology of their name, atoms are not indivisible, that we can “pry” electrons from them, we can break their nucleus, and so on. However, the name remained, designating, in the collective mind, if not in that of the specialists, the smallest possible particle, identifiable as such.

But it is completely daunting to think about the size of an atom. Calculations show that it has a size of the order of  $10^{-10}$  m, that is one tenth of a millionth of a millimetre! And its nucleus is about  $10^{-15}$  m in diameter, that is a hundred thousand times smaller than the atom itself! As for the electron, theoretically, it is a point particle, therefore it does not have a dimension. This means that 99.97% of the mass of an atom is in its nucleus! However, also theoretically, the particles that form protons and neutrons are, like the electron, point particles, that is particles without volume, full of void. Therefore, as the nucleus is very small, the mass of an atom is extremely concentrated. So concentrated that if we removed the vacuum around the atomic nuclei, the Earth could be condensed into a sphere with a radius of only 150 m!

Does that mean, then, that the atom is vacuum?

The above calculations lead to the conclusion that the volume of the atom consists of at least 99.999999999999999% vacuum! We reach scales of magnitude that are elusive to us, since our minds are equally incapable of conceiving the small infinity as they are the great infinity. *Void, veda* - the same etymology in Sanskrit, the root of the verb *to know*. We return again and again to Vedic knowledge for answers...

But today’s scientists have not stopped here with their research. Taking into account the suggestions of string theory, they consider that the quantum vacuum is part of the particles, but also contains them. Hence the deduction, shared by Leonard Susskind (*The Cosmic Landscape*), that vacuum is “a list of all the elementary particles as well as the constants of nature that would be revealed by experiments”, being at the same time “an environment in which the Laws of Physics take a particular form” (2006: 279). Therefore, we can say that the entire universe arose from the energy of the vacuum, of the particles that populate it, but which appear and disappear so quickly that they cannot be detected under ordinary conditions, which is why physicists call them virtual.

Is it natural, however, to wonder: where do these virtual particles come from? The answer is given by Heisenberg, in his principle of uncertainty, according to which, if we remove all particles from a small volume of space, it is not *nothingness* that remains in their stead, as pairs of particles and antiparticles appear constantly (it is necessary for the corresponding particle and antiparticle to emerge simultaneously, as the electric charge must remain unchanged), and immediately annihilate each other. Therefore the supposed empty space is, in fact, something very complicated, like a “soup” of particles in constant agitation. On the Plank scale of the world, where dimensions are so small that they no longer mean anything (to us, their Gullivers!), space is nothing like what we can imagine. But this quantum “foam” has immense energy, the sum of the energy of all virtual particles being, according to calculations, greater than that which would be produced by all the stars in the universe, in their entire life, according to the same Susskind. Such energy should simply pulverise the universe. But this is not the case, which means that physicists have still to understand something fundamental. “We made a prediction based on the best theories we have, and it is wrong, woefully wrong”, says Sean Carroll, a physicist at the California Institute of Technology...



Perhaps it is not without interest to present here two comparative tables that can justify the attraction felt by so many great researchers for the rigorous (and poetic) traditional Indian thought. We shall look at the research of the Indian physicist, Rajat Kumar Pradhan (*Particle Physics and the Vaiśeṣika System: A Comparative Analysis*, 2015), from Uktal University. Here are two figures that compare the physical system of the Vaiśeṣika school (Figure 2) and that of contemporary physics (Figure 3), from the perspective of indivisibility and eternity of the ultimate particle. We shall not explain them scientifically, this is neither our purpose here nor are we in a position to do so (complete information can be found in the quoted article), but we believe that these schematics are in themselves sufficiently edifying to support a arc over time, the idea of an original community of thought, beyond disparities and historical, cultural and technological peculiarities.

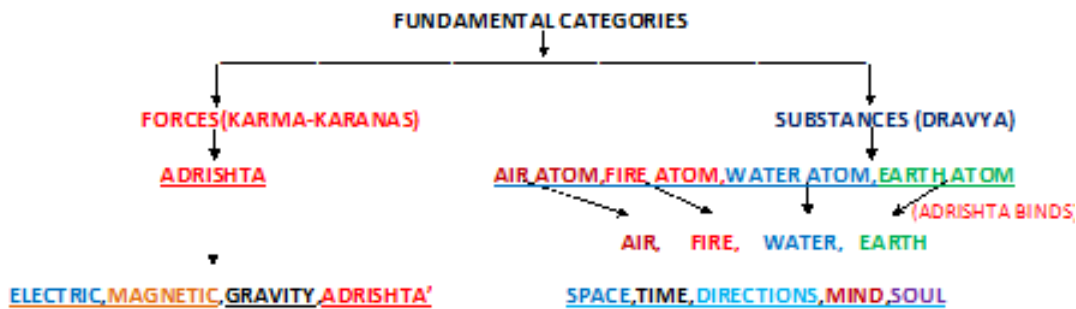


Figure 2: The Vaiśeṣika classification.

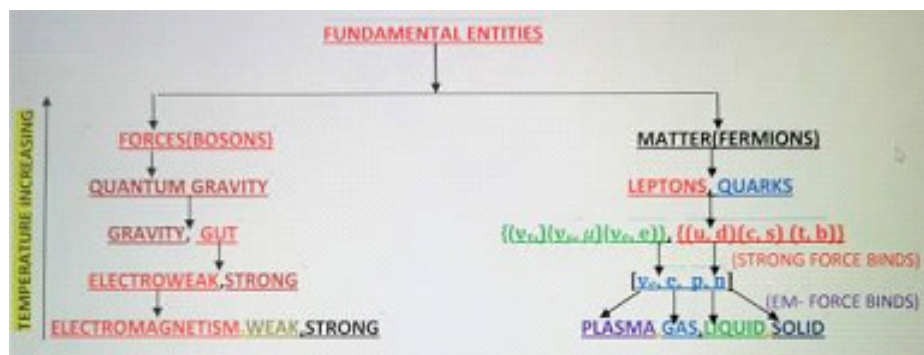


Figure 3: The quantum physics classification

We only mention that, for the Vaiśeṣika school, the mind also appears as an indivisible and eternal atomic particle, and *Adrishta* designates the fundamental or invisible force. In the opinion of the Indian researcher, this is probably the supreme unifying force that can explain all the phenomena involving matter and mind. Traditional Indian philosophy looks holistically at the entirety of our experiences, not just at the physical, quantifiable and subject-to-experience part, as Western science does. Or as it has done until very recently, because these classifications and relationships can not help but lead us to think of the *bootstrap* theory, or of *implicit order*.

\*

Finally, let us add that in his 2016 book, suggestively titled *La Plénitude du Vide*, the famous astrophysicist Trinh Xuan Thuan reminds us of the first verse in the *Rig-Veda Creation hymn* (X, 129), which says: *Then was not non-existent nor existent*, therefore, at the origins, before the being, there was nothingness, void, emptiness, not even the non-existent existed, but only the primordial vacuum, full of potentialities waiting for their actualization.

The central problem is that all these exhilarating discoveries awaken in us again the restlessness and ambition of total knowledge. Modern physics tells us that the universe appeared about 13.7 billion years ago, through a grand explosion. We can explain its evolution so far, we can make predictions based on calculations and models, but we are still bothered by an unresolved question: what happened there, at the beginning of the beginning, before the time  $t = 10^{-43}$ s? In other words, what good is it to be able to describe what happened to the universe *after* time and space began to exist, if we can not know what was *before*? We rummage through the affairs of the gods, forgetting they were angry with Prometheus for much less...

Taking a quick look back, we shall find that all ancient thinkers, be they Indian, Greek, Chinese or Egyptian, as well as philosophers and scientists all the way to the dawn of the modern age have solved this torturous question as simply as possible. By eliminating it. Whatever we call the root cause of the universe, it is the one that generates the creative process. They did not question the possible root cause of the root cause, because our minds cannot conceive of such a thing. In the same *Creation Hymn* we see how the One emanates the whole reality, plurality being only an appearance, and the end of this hymn seems to us really essential (our highlight):

Who verily knows and who can here declare it, whence it was born and whence comes this creation?  
The Gods are later than this world's production. Who knows then whence it first came into being?  
He, the first origin of this creation, whether he formed it all or did not form it,  
Whose eye controls this world in highest heaven, *he verily knows it, or perhaps he knows not.*

Is there nothing to be learned from this multi-millennial wisdom?

## 2 From holograms and fractals to the informational paradigm

We relearn to live and think under the tutelage of *holos* (in ancient Greek, whole, entirety). Plato left us an important legacy in his series of *Dialogues* that summarize parables learned from his mentor, the philosopher Socrates. And one of the best known myths is that of the cave (*Republic*, Book VII). In this allegory, let us remember, people appear as chained from birth in a cave, so that they can only see the shadows cast by a fire on the cave walls. For these people, shadows represent their entire existence – it is impossible for them to imagine a reality that would consist of anything other than the blurred shadows on the walls. At some point, a prisoner manages to escape from the cave, goes out into the sunlight and sees the reality, but when he returns to the other captives and tries to tell them the truth, he is mocked like a madman. In Plato's time, this story symbolized man's struggle to escape the captivity of the material world and to reach understanding through critical thinking and an open mind. What if, beyond allegory, we read the Platonic myth in its literalness? We are then confronted with the idea that reality could be fully represented by those "shadows" on the walls.

The holographic principle, reminiscent of Plato's allegory, seems to many just as obscure and counter-intuitive: how can all complex phenomena, occurring in a three-dimensional space, be equivalent to the shadows dancing on the cave walls? That is, can all the information contained in our body be, in fact, represented by our "shadow"?

One of the starting hypotheses of quantum mechanics was that information can be stored in every volume of space. It has been called the Holographic Principle, and in one form or another we find it in most contemporary thinkers. For example, the physicist and philosopher David Bohm talks about inseparability and *holography*, and the philosopher and sociologist Edgar Morin talks about hologrammaticity or hologrammatic property, both subsuming them to another fundamental principle – the *relationship*. For Morin, the relationship is at the heart of the notion of complexity, on which his entire system is built. For


David Bohm, particles appear when the field folds onto itself, like a cord whose two ends intersect when we want to connect them, thus delimiting a point of contact that is the particle.

Bohm asserted that relativity and quantum theory are in a fundamental contradiction in terms of their essential aspects and that a new concept of order should begin with the one to which both theories point to: *undivided integrity*. The physicist challenged the scientific orthodoxy of reductionism, which has contributed immensely to the success of science over the past four centuries, by breaking up and fragmenting things. But Bohm's point of view is the exact opposite of the reductionist approach. Bohm does not believe that the world can be reduced to a set of indivisible particles in a three-dimensional Cartesian grid, or even in the three-dimensional curvilinear space of the theory of relativity. Instead, the physicist embraces a concept of reality as the dynamic motion of the whole, which he calls *holomotion*: in his 1980 book, *Wholeness and the Implicate Order*, he first presented the hypothesis of the holographic Universe.

The bootstrap theory, developed by American physicist Geoffrey Chew in the 1960s, came with a radical approach to a self-determined and self-sufficient universe. It is another view of elementary particles that puts aside the concept of fundamental entities and states that it is necessary to understand atomic and subatomic reality through the principle of self-consistency, because the structures of matter and those of intelligence or consciousness are reflected and intertwined, and that, after all, nature is what it is because it is the only nature coherent with itself. This novel perspective corresponds to Bohm's idea of implicit order, in which matter and consciousness intertwine, but not in a causal relationship, but in one of mutual containment, referring to a higher reality, which transcends both. But the bootstrap theory was quickly buried, too revolutionary for the inertia of thinking of the time, only to be rediscovered and reactivated today, in geometry and astrophysics, for example contributing fundamentally to the writing of the equations that led to the discovery of the Higgs boson.

Here we are, having entered the paradigm of the world as a network of relationships, a concept now taken over and developed in many sciences and applied to many disciplines: *reality is a network of relationships* and each part of this network can be understood only in relation to the rest; this means we are no longer talking about fundamental properties independent of the connections with the environment. The concept of relationship has become more important than that of structure or entity or object, and the logical coherence, the self-consistent coherence of these relationships is what determines the structure of the overall network. Some researchers speak of a noetic paradigm (from the Greek word *noûs*: knowledge, spirit, intelligence), which focuses on the study and development of all forms of knowledge and creation that generate and feed the noosphere, this "layer" of knowledge and information that covers the entire Earth with its networks.

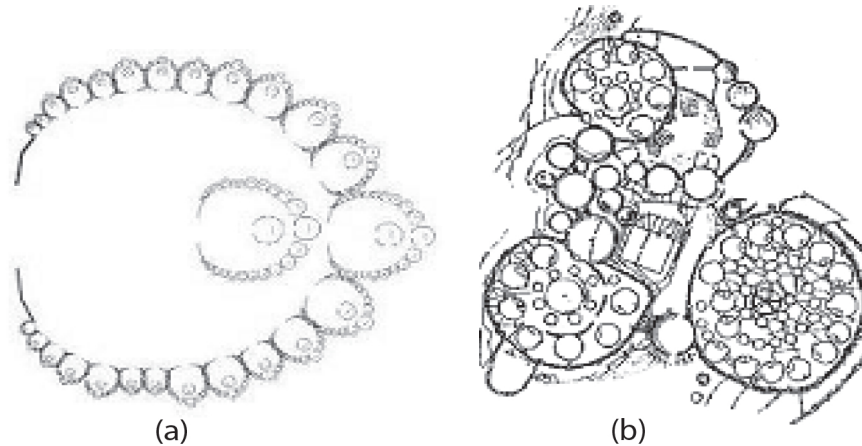
But our universe displays not only the characteristics of holography, but also of *fractality*. As above, so below. Nature is now known for layering and repeating patterns of complexity. Fractality is another way for the multiversal structure to self-organize, optimize, and compress data, but more importantly, it compacts the universal structures *ad infinitum*, into a mathematical representation of infinite fractal propagation.

In his well-known book, *Les objets fractals, forme, hasard et dimension / Fractals: Form, Chance and Dimension* (1975), Benoît Mandelbrot laid the foundations of a theory of certain sets of things that can be expressed as infinite sets of precise replicas of them, scaled down and called fractals. The term comes from the Latin word *fractus*, which means broken, fractured. The name is not accidental, because, in addition to the self-resemblance characteristic, it illustrates another essential characteristic of fractals, which distinguishes them from classical mathematical objects: they are not smooth, but have a completely irregular character. Although it was Mandelbrot who formulated the theory of fractals, between 1830 and 1970, many mathematicians (Cantor being perhaps the best known of them) noticed the existence of bizarre, seemingly paradoxical forms, which highlighted the limits of classical analysis, far too restrictive in the face of nature's diversity and irregularities. In fact, fractals appeared in mathematics about 300 years BC, in the treatises of Apollonius of Perga, later rediscovered in 1528 by the research of Albrecht Dürer (who first observed and studied the fractal pentagon ).

Fractals are widely used in modelling the appearance and behaviour of natural systems because they can represent with ease similar shapes that act on multiple levels, while linear geometry cannot. Fractal

geometry is practically the missing complement of Euclidean geometry. Also with the help of fractals, biologists and psychologists have managed to diagnose the “dynamic diseases” that occur when fractal rhythms become synchronized.

Obvious and natural examples of fractals are, for example, fern leaves or snowflakes, but scientists such as ethno-mathematician Ron Eglash (*African Fractals: Modern Computing and Indigenous Design*, 1999), following in the footsteps of Mandelbrot, have discovered that fractals are also a very ingenious way of predicting the future in ancient African civilizations, or that the shape of West African villages corresponds to a fractal geometry.



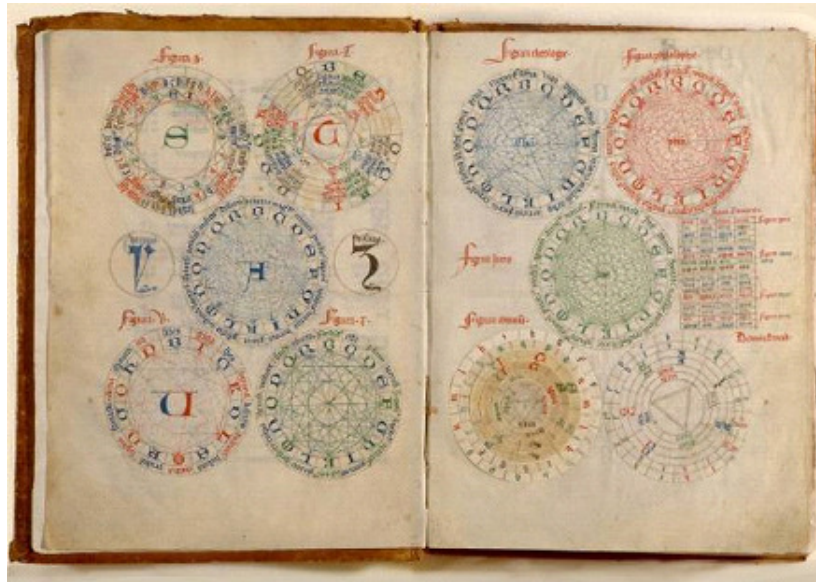
**Figure 4:** (a) Layout of the Ba-Ila village in South Zambia  
(b) Layout of the Mokoulek village in Cameroon

Moreover, although our Eurocentric arrogance, doubled by the cult of technological modernity, leads us to believe that all the great discoveries of mankind come from us and that they are relatively recent, there is clear evidence that Africans invented the “digital computer” as early as the tenth century. In an exciting book, *Histoire de la modernité* (2012), the scholarly professor and economist Jacques Attali talks about the so-called “Bamana code” (the Bamana or Bambara population being, along with the Dogons, in the Mali area, the repository of amazing knowledge, often disguised in myths and rituals), a system for predicting the future, based on simple logic, which is exactly what we call binary code (0 and 1) or Boolean code in modern mathematics, which is the basis of today’s digital computer.

In fact, we know very well how things developed. This “Bamana code” started from West Africa in the tenth century, picked up by Arab traders, arriving in Cordoba with Hugo Santalia in the twelfth century, then making its mystical entry and alchemical practice, under the name of geomancy, developed and refined by the brilliant mind of the Catalan Ramon Llull (Figure 5), in his *Ars combinatoria*... before reaching the Netherlands and the mathematician and philosopher G.W. Leibniz (17<sup>th</sup> century), from whom George Boole borrowed the binary code, creating his now-famous Boolean algebra (in the 1850’s), based on which John von Neumann created the digital computer (in the 1950’s). How simple and coherent appears to be the essentialised history of human thought when we look at it in elliptic leaps! (Ron Eglash, *African Fractals: Modern Computing and Indigenous Design*, Rutgers University Press, 1999)

In this context, the concept of *hologram*, that is a recording of a three-dimensional image on a generally two-dimensional environment, returns to attention. The method was discovered in 1947 by the Hungarian physicist Dennis Gabor, but could not be widely applied until after 1960, with the invention of the laser. The essential difference between a photograph and a hologram is that, in the case of the hologram, the information about each point in the object is not strictly located in a certain area, being instead

global, distributed over the entire surface of the hologram. Cutting a person's hologram in half and then illuminating it with a laser beam, we notice that each half contains the entire image of that person. Continuing the experiment recursively, if the two halves are split again, each new part will contain an obviously smaller, but intact, version of the original image. Each part of a hologram thus contains all the information held by the whole.



**Figure 5:** *Códex* written by Ramon Llull (1232-1315). *Cod. Cus. 83: Raymundi Lulli Opera*, version published in 1428 (St. Nikolaus Hospital-Cusanusstif Bibliothek, Bernkas)

In collaboration with renowned neurophysiologist Karl Pribram, the already mentioned quantum physicist David Bohm helped develop the *holonomic* brain theory, a model of human cognition that describes the brain as a holographic storage network, in which the universe appears as a huge hologram created by the mind, in accordance with quantum mathematical principles and the characteristics of the corresponding models. Pribram believes that, in itself, the brain is a hologram. He believes that information is not encoded in neurons or in restricted formations of neurons, but instead in the configurations of the nerve impulses that intersect in the brain. Each unit of information seems to be interconnected with any of the others, which is an intrinsic feature of the hologram. If reality is nothing but a holographic illusion, then the old paradigm according to which the brain produces consciousness can no longer be true. It seems to be the other way around: consciousness creates the appearance of the brain, the physical body and all the things that surround us and that we perceive to be real.

With technical innovations, relationships, networks, complex thinking become essential dimensions, and *information* becomes nested in the core of human life, covering all aspects of existence, from physics and biology to the social sciences. We all acquired, in a short time, an “informational nature”, and the main way of modelling, therefore of quantifying information is to use patterns of symbols and the relations between them. No symbol is independent, none can be intelligible and cannot function outside a framework of representation, a “grammar” proper to a given system, within which the symbol creates various associations and networks. And in a scientific approach, information is generally defined in relation to a given symbolic system, which is accepted as a model for a particular situation or environment (especially after visionary researchers such as Alan Turing, John von Neumann, Norbert Wiener and others laid the foundations of this informational paradigm in the first decades of the 20<sup>th</sup> century). But her, things have separated

significantly because, in the “exact” sciences, mathematical language is considered to be the most direct and rigorous, being a convenient tool for translating symbolic systems, while in the “human” sciences, in literature, in art, the ambiguity and polysemy of symbols are privileged. A separation that the new paradigm no longer justifies and which is convincingly, successfully and in a particularly exciting manner cancelled by the epistemology of transdisciplinarity.

### 3 The transdisciplinary vision

The origin of the concept of transdisciplinarity must probably be sought in Niels Bohr’s (1955) article on the unity of knowledge. The word does not appear as such, but the concept is clearly expressed: “The issue of the unity of knowledge is closely related to the search for a universal understanding, intended to elevate human culture” (p. 272). This general attitude, characterized as an effort to harmonize increasingly vast and complex issues, was determined by the quantum revolution.

It is not easy to locate in time the word “transdisciplinarity”. However, a precise reference is the text written by Jean Piaget in 1970, during a conference on interdisciplinarity: “Finally, in the stage of interdisciplinarity relations, we can hope to achieve a higher stage that would be” transdisciplinary, “which would not be content with achieving interactions or reciprocities in specialized research, but instead would situate these links in an overall system, without stable boundaries between disciplines” (1967: 1151). After this date, several authors, especially in France, tried to clarify their view of transdisciplinarity, the first being Basarab Nicolescu (1985, 1993) and Edgar Morin (1994).

Transdisciplinarity concerns - as the prefix “trans” indicates - what lies at the same time between disciplines, as within various disciplines, as beyond any discipline. Its finality is the understanding of the present world, one of its imperatives being the unity of knowledge.

(Nicolescu, 2007:53)

In other words, within and without disciplines, the search for meaning is established by rediscovering the unity of the universe, life and man, tearing down the walls between forms of knowledge and practicing, according to Basarab Nicolescu’s fortunate formula, a “jubilant transgression”. Here are the main points of the principles it establishes:

- Transdisciplinarity is incompatible with a reduction of man to a formal structure and with the reduction of reality to a single level and to a single logic.
- Transdisciplinarity offers a new vision of nature, by opening disciplines to what intersects and transcends them. It goes beyond the realm of the exact sciences, which it seeks to reconcile with the human sciences.
- Transdisciplinarity relocates man in the universe.

In short, transdisciplinarity acknowledges that science has reached nowadays the frontiers of metaphysics, and that quantum physics, the evolution of matter after the Big Bang, the standard model of cosmology, etc. cause human beings to ask again the questions that science cannot answer: Where do we come from? Who are we? Where are we going?

Transdisciplinarity comes to meet the needs of this new type of civilization, which is not a natural extension of the past, because the mental mechanisms that have reigned for centuries are about to die out, in order to allow a metamorphosis to occur, a radical regeneration of knowledge, which becomes increasingly compartmentalized, disjointed and hyperspecialized. All these questions, and more, will be also addressed in the last chapters.

For Basarab Nicolescu, the notion of transdisciplinarity is inseparable from the quantum revolution which fundamentally challenged the belief that scientific truth has completely exhausted the field of truth and knowledge, just as it is inseparable from two other fundamental notions: *levels of reality* and *the included third*.

### 3.1 Levels of reality

According to the Romanian physicist and philosopher, the notion of *level of reality* is distinct from that of *level of organization*. The notion of *reality*, which runs through the entire philosophy of Plato in Kant and Auguste Comte, has been challenged by quantum physics, which has led to the recognition of different levels of reality. Basarab Nicolescu states that by *reality* he understands “what resists our representations, descriptions, images. By level I understand a set of natural systems that is invariant under the action of certain laws” (2007: 51). He makes a distinction between *reality* and *the real*, which is “what is” and can never be fully known. Reality therefore designates whatever can be represented or described, whatever we can transpose into language, images or mathematical formulas, that is to say what is rationalizable, as well as what is verified and confirmed through experiment.

The transition from one level of reality to another is far from being explained, because it is both continuous and discontinuous. The microphysical transition is particularly disturbing, because the laws and properties that characterize the quantum level seem irreconcilable with those of the classical physical level, violating all the principles that govern classical thinking, namely the principles of intelligibility, identity, location, causality and separability. Numerous physicists are trying to articulate these two levels of reality, as we know, but so far no perfectly viable theory has been proposed.

But the transition from the physical to the biological level is also a gap that appears to be unexplainable, insofar as, despite some progress, researchers still do not agree with the modalities and stages of this transition. It is true that there is an almost infinite distance between the most complex molecules found in nature and the simplest unicellular being, such as a bacterium. It is not enough to know the structures and functions of a bacterium to understand how it came to be in this world, endowed with certain radically new properties that would remain common to the entire living world.

Regarding the transition from a neuronal activity of an electrochemical nature to a conscious psychic activity consisting of images (representations) and emotions, it remains largely an enigma. Indeed, not only do these images and emotions constitute a different level of reality from the previous ones, but, in addition, they imply that a “subject” perceives and experiences them. Finally, language and reflexive thinking, which represent a psychological reality different from that of perception, are far from revealing the ways and stages of their emergence.

Merely listing the levels of reality proves that each has its specific laws and properties, although they depend on those of the basic levels. Since these laws and properties can be defined – but not explained – without taking into account those of the basic levels, each level gives the impression that it transcends those on which it depends. Thus, psychology is able, within certain limits, to develop into an autonomous discipline, without the need for neurobiology knowledge, but only to the point where only the knowledge of neurobiology makes it possible to explain certain phenomena. If we knew how the transition from one level of reality to another occurs, we would be able to integrate the local into the global.

As far as science is concerned, transdisciplinarity exists only based on disciplines. Scientific knowledge had to reach a certain level of development and all the disciplines had to accumulate significant results for true transdisciplinarity to be possible, although holistic attempts have always existed, as we have seen. Disciplinarity and transdisciplinarity are complementary when it is possible to establish intersections and relationships between all areas of knowledge and all components of the universe, of which man is an integral part, being in constant interaction with them. It is, however, an illusion to think that, one day, this “theory of everything” that scientists dream of could be formulated. Ever since Gödel gave us a subtle and difficult proof of his incompleteness theorem, we have given up complete and closed theories in favour of an open and evolving worldview in which levels of reality are articulated rather than excluded. Transdisciplinarity recognizes the coherence of all levels of reality, but does not forget that it is impossible to observe them all at the same time, that the problem of transitioning from one level to another remains open, as does that of articulation between levels of organization. Man has the intuition of the unity of this whole, but since he is part of it, he cannot explain it.

In the same vein, notions of the level of reality and organization forbid the reduction of the “superior” to the “inferior”. Thus, the level of conscious representation, that of sound, visual and other images

remains an emergent one and cannot be reduced to that of electrochemical neural phenomena, which are nevertheless the condition of the former.

Whereas each discipline, through in-depth research, reveals more and more of the complexity of structures and processes, transdisciplinarity reveals another aspect of complexity, that of the exchanges and interactions between the constituent elements of the universe, Earth and man. Thus, transdisciplinarity will not eliminate from its field of research the sphere of the sacred, because it is precisely what connects the object and the subject, thought and experience, the effective and the affective, the one that transgresses dualities and operates transmutations. Such an exploration underlines the isomorphisms and analogies that bring these traditions closer together and tend to the “peak” of infinity, where the last convergences sink into Unity, without however seeking false dissolving syncretisms, but on the contrary, fully respecting every tradition related to the primordial, shared background.

### **3.2 The Circular causality**

Another important concept is that of circularity or loop. It has been often used without being named. When Pascal said, “It seems impossible to me to know the whole if I do not know the parts, or to know the parts if I do not know the whole”, he stressed that true knowledge is the one that follows the circuit from knowing the parts to the whole and from knowing the whole to knowing the parts. Norbert Wiener explained this idea in his own way, talking about a regulatory loop, in which the return of the effect on the cause cancels the deviance, thus ensuring a relative autonomy of the system. It is obvious that this idea of relative autonomy was all the more important as it had been inconceivable previously, because the determinism of classical science was based on a causality external to objects. And it is not the only type of loop. The most interesting and powerful is the self-generating or recursive loop, the most convenient example being ourselves, who are the products of a cycle of biological reproduction in which we become producers, so the cycle can continue. We are products that produce. Thus, society is the product of interactions between individuals, but, globally, new qualities appear that, through feedback to individuals – through language, culture, etc. - allow them to realize themselves as individuals. Individuals produce the society that produces individuals.

Thus we understand better how interdependencies are constructed. The more autonomous our mind wants to be, the more it has to feed on various cultures and knowledge. Schrödinger had already stated that we carry otherness within our identity, at least the otherness of the environment. In our identity as social individuals, we carry the otherness of society. In our identity as a thinking subject, we carry the otherness of the genetic inheritance which is that of humanity, and the instinctual inheritance, which is that of our animality. And so we come to a number of concepts that should allow us to become closer and connect, instead of becoming separate.

### **3.3 The Complex thought**

Because we have discussed it separately before, we shall link the hologrammatic principle to complex thinking. In a system, in a complex world, it is not just the part that is in the whole, but also the whole is in the part. Not only the individual is in a society, but also the society is in him, instilling in him from birth, a language, a culture, prohibitions, customs, mentalities, values; and man carries in him particles that were formed at the beginning of the universe - carbon atoms, the macro-molecules that appeared before life was born. We carry within us the mineral kingdom, and the vegetable kingdom, and the animal kingdom. We are, in a way, the microcosms of the macrocosm, mirrors of the cosmos; in our singularity, we carry within us the whole universe, in the widest and most solid network imaginable.

Kant also develops such a reflection, which has retained all its acuity and relevance, especially in the very complex contemporary debate around artificial intelligence and natural intelligence, or in that around transhumanism:

Any space intuited within its boundaries is such a whole, whose parts in every decomposition are in turn spaces, and it is, therefore infinitely divisible. (...)



The infinitude of the division of a given appearance in space is grounded solely on the fact that, through this infinitude, only the divisibility (in itself, as regards the number of its parts, absolutely indeterminate) is given - the parts themselves being given and determined only through the subdivision. In a word, the whole is not in itself already divided. The number of parts, therefore, which a division may determine in a whole, will depend on how far we care to advance in the regress of the division.

In the case of an organic body articulated to infinity [...] the whole is represented through this very concept as already divided up, and a multiplicity of parts, determinate in itself but infinite, is encountered prior to every regress in the division - through which one contradicts oneself, since this infinite development is regarded as a series that is never to be completed (as infinite) and yet as one that is completed when it is taken together.

It is the reform of thought that makes possible the integration of these types of connections; a complex thinking that is not afraid to approach with serenity and force at once both separation and connection. Which is not very difficult to do if we understand that “reality is plastic”, as Basarab Nicolescu (2009) stated, that we are part of it, that it “changes due to our thoughts, feelings and actions”.

In 2005, François Martin presented a theory in which the human psyche is viewed as a field of consciousness of a quantum nature, which would be universal and would extend to the unconscious level. The human psyche would thus have a formal representation analogous to a quantum system, with virtual states and physical states that correspond respectively to the potential and the actualization of the human mind. Free will plays a central role in moving from potentiality to actualisation and vice versa. Before becoming actualized through free will, the human spirit would be in a state of overlap. This overlap would result in particular in the possibility of two human psyches being quantum entangled, similar to quantum systems.

We are experiencing a paradigm shift, as we have said before, we are gradually emerging from the era of reductionism, of segmentation detrimental to knowledge. Any new paradigm, through its mode of operation, modifies, shifts the expectation horizon, directs and conditions the conscious psychic activity. It is convenient, in the sense that it facilitates the reading and interpretation of the world and of our relationship with it, guiding it through already established schemes and models. But, Edgar Morin warns us that “the paradigm is blinding (...) The paradigm is invisible, located in the order of the unconscious and the superconscious, it is the invisible organizer of the visible organizational core of theory” (...) (1991: 216-219). A great paradigm determines, through theories and ideologies, a mentality, a “mindscape”, a vision of the world. The possibility of “thinking differently” undoubtedly remains open, but it cannot depend on a simple effect of willpower.

The field of knowledge is increasingly overlapping with the field of communication and information, and if we want to find the meaning of “universality”, we must keep in mind that the current evolution is no longer based on the cumulative acquisition schemes previously practiced, but instead on multidimensional processes. Transdisciplinarity manifests itself not only as an evolution of the multi-inter-plural-disciplinary triad, but as a path from sequentiality to the dynamic recovery of integrity. This epistemology raises questions on the stage of an investigation of scientific ways of thinking and, consequently, forces us to ask ourselves questions about their true degree of autonomy, because no science has all the keys necessary to elucidate its own object in the very register in which it claims to own them.

Transdisciplinarity can also be defined as a common system of axioms for a set of disciplines, insofar as notions such as *complexity*, *hybridity*, *nonlinearity*, *reflexivity*, *heterogeneity*, *dialogical*, *circular causality*, *holistic perspective* are increasingly used and end up producing theoretical structures, research methods and modes of practice that are not “localizable” on a monodisciplinary map. Knowledge is dynamic, it breaks more and more easily the classical societal and cognitive constraints towards a continuous form of network of connections and mutual influences, always generating new configurations, to a coherence, to the detriment of fragmentarism. These transgressions of borders affect all areas, as the erosion of nation states, the globalization of economic activities, the explosive development of information technologies and the new models of cultural diversity and multiple identities have created a new constellation that no longer fits into the old systems and concepts of strict differentiation and classification. Some authors, such as Basarab Nicolescu dare to speak of a new Renaissance, in which the watchword is the permanent movement both ways across thresholds.

But interdependence and cohesion do not mean the cancellation of differences and identities, their melting into an amorphous magma, but rather their placement into a relationship and under a mutually enriching light. The great prize of transdisciplinarity is the replacement of a disjunctive type of thinking with a correlative, open, creative type of thinking.

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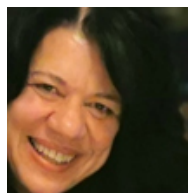
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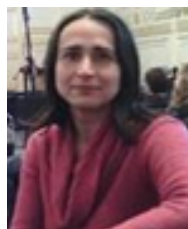
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## About the Authors



**Simona MODREANU**, university professor, director of the Department of French language and literature at the Alexandru Ioan Cuza University in Iasi (Romania), translator. PhD from the University of Paris VII. Director of the Romanian Cultural Center in Paris (1999-2001). Author of the books: *Cioran or the forbidden prayer* (Iasi, 2002); *Eugène Ionesco or the agony of significance* (Iasi, 2002); *The Paradoxical God of Cioran* (Paris, 2003); *Cioran* (Paris, OXUS, 2003); *Nomadic Readings* (Iasi, 2006); *Sedentary Readings* (Iasi, 2010), *Unfaithful Readings* (Iasi, 2014), *Fluid Readings* (Iasi, 2018), *The Atom, an endless story* (Iasi, 2020); *Cioran or the chance of failure* (Paris, 2021).



**Alina GAVRILUȚ** is a PhD lecturer in the Department of Mathematics at Al.I. Cuza University of Iasi. She is editor and member of the Editorial Board of several international mathematics journals. Her areas of interest are theoretical and applied mathematical analysis, focusing on the theory of classical and non-additive (set) measurements, general topology and hypertopologies, nonlinear dynamics. She has published over 50 articles in ISI journals, 11 books, and has given numerous papers at national and international scientific events.



**Maricel AGOP** is a professor in the Department of Physics at Gh. Asachi Technical University of Iași. His main area of interest is the use of nonlinear dynamics in the study of different physical systems (plasma, nanostructures, composite). In recent years, he has turned his attention to biological systems, especially those related to medicine (solid tumors, cancer cells) and the pharmaceutical field (nano-structured drug delivery systems). He has published over 260 articles in ISI journals and 90 books in Romania and abroad. Since 2018, he is a corresponding member of the Romanian Academy of Scientists.



**Gabriel CRUMPEI** graduated from the Faculty of General Medicine of the University Gr.T. Popa and the Faculty of Theology of Alexandru Ioan Cuza University. He specialized in psychiatry and received his doctorate in psychology in 2003. He is the director of a Center for Psychiatry, Psychotherapy and Counseling. He is also an associate professor at the Faculty of Psychology of Alexandru Ioan Cuza University in Iasi. His main interests are psychology, psychiatry, theology, physics and neurosciences. He is the author and co-author of several ISI papers, books and book chapters and has given numerous papers at national and international scientific events.

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